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THE ENGINEER'S EDUCATION.

At the recent meeting of the American Institute of Electrical Engineers a long discussion on the education of the engineer, with special reference to the electrical branch, followed the reading of two papers on this subject, both of them by distinguished electricians who have shown more than the usual interest in educational matters. As might have been expected, a considerable diversity of opinion was shown by those who took part in the discussion, but the general trend was certainly in the direction in which the colleges themselves have been moving. This is toward a more thorough grounding in fundamental principles and the essential sciences upon which the arts are based; a more thorough training of the student's mind, making him better fitted to think for himself and in giving him a somewhat broader view of life than is obtained if he never reads anything but his electrical books.

This is undoubtedly the proper course to pursue. In fact, even were it not the most logical method, it would be forced upon many institutions by the great diversity of the applications of electricity. Only eight or ten years ago there threatened to be a demand for more highly specialized technical education, and more than one institution offered several electrical courses. But to keep up with all branches of electrical application, even were it desirable, would to-day be practically impossible. Moreover, too much attention to details tends rather to produce a skilled artisan than an original thinker and leader. The latter must know his fundamental sciences. In fact, they must become second nature, so that he instinctively goes to the right result without painfully tracing every step. This is what is so frequently termed common sense, which all admit is a prime essential of the engineer.

The question for the college, then, is How much time should be given to theory, pure and simple; how much to application, and how much to those broadening studies having no intimate connection with the student's selected profession? The proper relation can not be laid down at once. It is a matter for development, and must necessarily change with the times, and it is the function of the school to balance these demands as best it may.

Throughout this discussion, as has been the case in the greater number of discussions of technical education, there is an insistent demand for what are termed "cultural studies." This, in one way, is an unfortunate use of the term since "cultural" means specifically "pertaining to mental culture or discipline," and the technical courses as laid out at the best engineering schools certainly lack nothing in this respect when compared with any

classical or non-technical course. The use of the term in this way intimates not only that the technical graduate is an uncultivated man, but that his mental training has been deficient, and it is, to say the least, irritating to have it inferred, if not flatly stated, that a strictly technical course has no cultural value. What is meant, of course, is that such a course is too narrow; that it does not give the man a broad enough view. It is too apt to get him into a rut from which he can not easily extricate himself. It is certainly true that the engineer can be more useful to the community if he can look at some problems from points of view other than those strictly technical. But is it not equally true of other walks of life, that they also are apt to be narrow? And would not the members of many other professions be greatly benefited if they could look at certain problems from the engineer's point of view? If, as we believe, the engineering professions are to become more and more important in the work of the world, will not such a condition justify the engineer in complaining that the non-technical schools are too narrow? Could not all professions apply with benefit Johnson's admonition:

> "Deign on the passing world to turn thine eyes,
> And pause awhile from learning, to be wise."

TROLLEY WIRE SUSPENSION.

The introduction of electric railway systems employing a relatively high operating potential drew attention to the mechanical deficiencies of the ordinary method of supporting the trolley wire. These had been realized for some time, particularly on those electric roads where high speeds were attained, but until the single-phase, alternating-current systems were devised only slight modifications in the old method of support had been made. It is true that in some of the experimental work new plans had been tried, such, for example, as that used in the Berlin-Zossen tests, but even in this notable example the principal modification consisted in supporting the wires from a short vertical span instead of from a short horizontal span, as has been done for some time.

This short-span method of suspension was an attempt to secure, in a bracket suspension, something of the flexibility of the span-wire method of support, and while it was a decided improvement over the old system in which the supporting hanger was attached directly to the bracket arm, it did not give as much flexibility of suspension as is now thought to be desirable. Moreover, except for a somewhat lessened liability of breaking of the trolley wire at a point of support, due to the increased flexibility of the support, on account of which the wire is bent somewhat less by the passage of the trolley wheel, there was no additional safeguard against the falling of a wire. When it was decided to use higher potentials, it was at once realized that there must be greater protection against such accidents, and it was this necessity which led to the various catenary methods of suspension, which not only support the contact wire at a number of points between the main supports, but also introduce additional advantages. They reduce the sag of the wire by decreasing the length of the spans. They therefore give a smoother surface for the wheel to run under, and increase very considerably the flexibility of the support, so that there is less tendency to produce a blow as the wheel passes under each point of suspension, and less liability for the wheel to leave the wire.

It seems very probable that more elaborate methods of suspension will be adopted for electric railroads in the future, no matter what system of propulsion be used. The tendency today, except for the strictly street railway systems, is to build a road resembling more closely the steam railroad. The cars are larger and heavier, and higher speeds are sought. For roads of this kind it is justifiable to go to greater expense in supporting the working conductor, if thereby it may be made more reliable; and the catenary systems seem to offer the simplest solution of this problem.

With regard to methods of suspension for lines running through towns, while possibly some modifications may seem desirable, there is not the same need for a catenary suspension, because the slower speeds of the cars throw less strain upon the wire and also because the potentials permitted when passing through towns will probably not be much higher than those at present employed. However, a modification for such systems has been developed by Mr. P. J. Pringle, electrical engineer for the Borough-on-Trent (England) railway systems. The idea of the new arrangement is to avoid the hammer-blow which takes place at every support when the latter is attached directly to the supporting bracket, and to a less degree only when a short span of wire is interposed between the bracket and the hanger. At the same time, it is sought to provide more flexibility than the short-span suspension gives. Incidentally a method of support is provided which makes possible the use of porcelain and earthenware insulators, doing away with the composition insulation now generally employed. In brief, the system consists in attaching a short span of steel cable to the trolley wire by means of soldered ears which do not interrupt the smooth under surface of the wire. These spans are about ten feet long and take up part of the tensile strain due to the span of trolley wire. The supporting cable is passed over a reel-shaped earthenware insulator, the working conductor passing under the support. The wire is thus supported from two points instead of one, a straighter run under the support is secured, and the wire is free to move vertically, laterally, and even longitudially, since the cable can slip along over the insulator. The method thus secures, in some degree, the advantages of the catenary system of support, although, of course, the wire is not carried as evenly as it is in the latter. The inventor suggests, however, that by using more than one span-wire attached to different points of the trolley wire, he can more nearly approximate conditions given by the catenary support and thus provide a suspension suitable for high-speed roads.

This method of suspension seems to be an improvement over that commonly used, and while it does away with some of the objections of the latter, it does not add as much to the overhead equipment as the catenary systems do, and which for this reason are less desirable within cities. The question of increased cost must, of course, be taken into consideration. This, the inventor

says, should not be more than that of the present methods of construction, though it would seem that an increased cost would be justifiable if greater security were obtained. Certainly there would seem to be less likelihood for line troubles where only earthenware insulation is used, and where the wire is so supported that it is not subjected to sharp bends and can adjust itself to various strains thrown upon it. The overhead trolley system will be with us for a long time to come, and in many towns and large cities it will remain the accepted system. It is therefore desirable that such improvements in this system as will increase its reliability, without introducing objectionable features, should be made. The safer the method of suspension, the less objection will there be to the use of the overhead trolley.

THE THERMOPHONE AND ELECTRIC WAVES.

Early during the development of telephony, when many attempts were being made to devise improved telephone receivers, an instrument known as the thermophone was constructed by Sir William Preece, in which the inventor attempted to use the changes in length of a fine wire due to alternate heating and cooling caused by a varying current to set into vibration a diaphragm which would convert these movements into sound. The instrument was constructed by attaching the wire through which the current was passed to a central point of the diaphragm, arranging it so that the telephone current would pass along the wire. The device did not constitute a successful receiver. A modified form consisted in using the alternate expansion and contraction of the air caused by the heating effect of the current in the wire to set into vibration the diaphragm; but while this arrangement would produce articulate sounds, it also was not a success as a practical receiver.

The effects upon which the two instruments just mentioned depend are well known, but it seems that there is another effect which may be used for translating the energy of electric currents into sound. This is the phenomenon made use of in the singing arc, in which the telephone current is superposed upon the main current of the arc and the variations in the latter which are thus produced give rise to sounds and even articulate speech at the arc. The action here would at first seem to be merely the variation in the temperature or size of the arc due to the change in current. This is easily understandable in the case of a gaseous conductor, but a solid conductor, it seems, will act in the same way. In a recent article in the *Elektrotechnische Zeitschrift* Dr. Frederick Weinberg shows that a heated solid resistance can reproduce a sound as well as the arc. The experiment by which this is shown consists in connecting a resistance in series with an arc, arranging the circuit so that a telephone current may be superposed upon the main current. Under proper conditions the arc will act as a telephone receiver, but by heating the resistance until the temperature is in the neighborhood of thirty-five or forty degrees centigrade, the arc may be cut out of the circuit and the heated rheostat will behave in the same way.

Conversely, by reversing the arrangement, a heated conductor may be caused to act as a transmitter. In this case the voice is directed against the resistance and an ordinary receiver, used in connection with a repeating coil, will reproduce the words spoken into the transmitter. The author suggests that the action may be due to the expansion of the heated metal, which allows the air to come into closer contact with the molecules of the metal, so that the changes in temperature of the resistance, due to the current variations, are more readily transmitted to the air, and, at the same time, the latter, by acting as an effective cooling agent, allows the heated conductor to follow closely the current changes. In fact, it was found that by directing a current of air against the heated conductor, a much better effect could be produced.

These experiments are most interesting, although they seem to have but little practical applicability to ordinary telephone service. They have, however, led to another investigation which promises valuable results. Arguing from the fact that the electric arc, when properly arranged, will give rise to electric oscillations—a property due to its falling current-resistance characteristic—it would seem that any other electric conductor possessing similar characteristics might be employed for producing the same effect. One such material is the glower used in the Nernst lamp. Trying the experiment, Dr. Weinberg arranged a glower in shunt with a circuit containing resistance and inductance, and found that, under proper conditions, electrical oscillations were set up. The best conditions are those which were found suitable for the oscillating arc. A cooling atmosphere, preferably hydrogen, should be used, as this gas is an effective cooling agent. Practically the same control over the apparatus is obtained as with the arc, but the conditions are more stable. Hence the oscillations set up are more regular and more likely to be continuous than those produced by the arc.

The effect may be of much use for wireless telegraphy or telephony. Its value depends upon the control which can be maintained over the oscillations produced, upon their regularity and the small damping effect. Another requisite, however, is the ability to set comparatively large amounts of energy into oscillation, and it is probable that a solid conductor of large dimensions would be more sluggish and less controllable than a smaller one. This difficulty could most likely be overcome by placing a number of small, thin conducting rods in parallel, and with such an arrangement there seems to be no reason why an oscillating current of any desired strength might not be obtained.

It is most interesting, in following the developments in wireless transmission of signals, to see how many ways and how many devices are being found which are more or less suitable for this purpose. As in the development of many arts, the start was made by an accidental discovery of a hitherto unnoticed phenomenon, in this case the action of a Branly filings coherer when subjected to electrical oscillations. Since then a comparatively large number of devices have been constructed, which behave in a similar way, although depending for their action upon entirely different effects.

Photo-Electric Property of Selenium.

This communication is a reply from R. J. Moss to one from G. M. Minchin, which is mentioned in the issue of the ELECTRICAL REVIEW for January 18. In the latter Mr. Minchin sad that he found that a selenium cell, when placed in a glass tube and exhausted, fell in resistance to about one-four-millionth of its original value and lost its sensitiveness to light. Mr. Moss says the explanation of this effect was probably due to the use of a mercury pump in exhausting the tube. Selenium combines readily with mercury vapor, producing a compound which does not possess the properties of the selenium itself. In reply to this Mr. Minchin says that Mr. Moss's supposition is correct. The tube was exhausted with a mercury pump; but when he repeated the work, using another type of pump, he found that the resistance of his cells increased instead of decreasing, and they retained their sensibility to light.—*Nature* (*London*), *January 2 and 9.*

An Important Wireless Telegraph Bill in the German Reichstag.

A bill to organize the business of wireless telegraphy in accordance with the decisions reached by the International Commission, which sat in Berlin in 1903, and the International Congress, which was held in 1906, has been introduced in the German Reichstag by the Minister of Posts and Telegraphs.

The fundamental principle is to compel navigation companies, as well as the owners of land wireless stations, to arrange for intercommunication without regard to the system used; otherwise permission for the erection of stations for wireless on board ships will not be given. It is understood that the enactment is intended to give the fullest scope to all systems.

Civil Service Examinations for New York State and County Service.

The New York State Civil Service Commission will hold examinations on February 15 for the following positions: assistant electrical engineer, $600 to $900 and maintenance; assistant steam engineer, New York County Jail, $840; bridge draftsman, $1,200 to $1,500.

The last day for filing applications for these examinations is February 8. Full information and application forms may be obtained by addressing Charles S. Fowler, chief examiner of the commission, Albany, N. Y.

DESIGN OF INDUCTION MOTORS.[1]

BY R. E. HELLMUND.

In the issue of April 7, 1906, of the ELECTRICAL REVIEW the writer gave a design method for induction motors, which uses the circle diagram for the predetermination of the motor performance. According to the method given there the short-circuit point on the circle is found by calculation, which, like any method devised for the same purpose, requires quite an amount of formulæ and figuring. Matters may be considerably simplified by calculating the copper losses for some other load condition in order to determine some points for the torque and output circle, after which all other load conditions, the short-circuit condition included, may be determined graphically.

In the following this method of procedure will be described in detail. In place of the diagram previously given, the corrected Heyland diagram, which gives more exact data for the power-factor, will be employed; moreover, the formulæ will be given so that they apply to fractional pitch windings as well as to full pitch windings.

As in the case of the method previously given, the magnetizing current, the core losses, friction losses, the electrical resistances of both members and the leakage coefficient of the motor are found by any of the well-known methods. The constant of the primary current is assumed

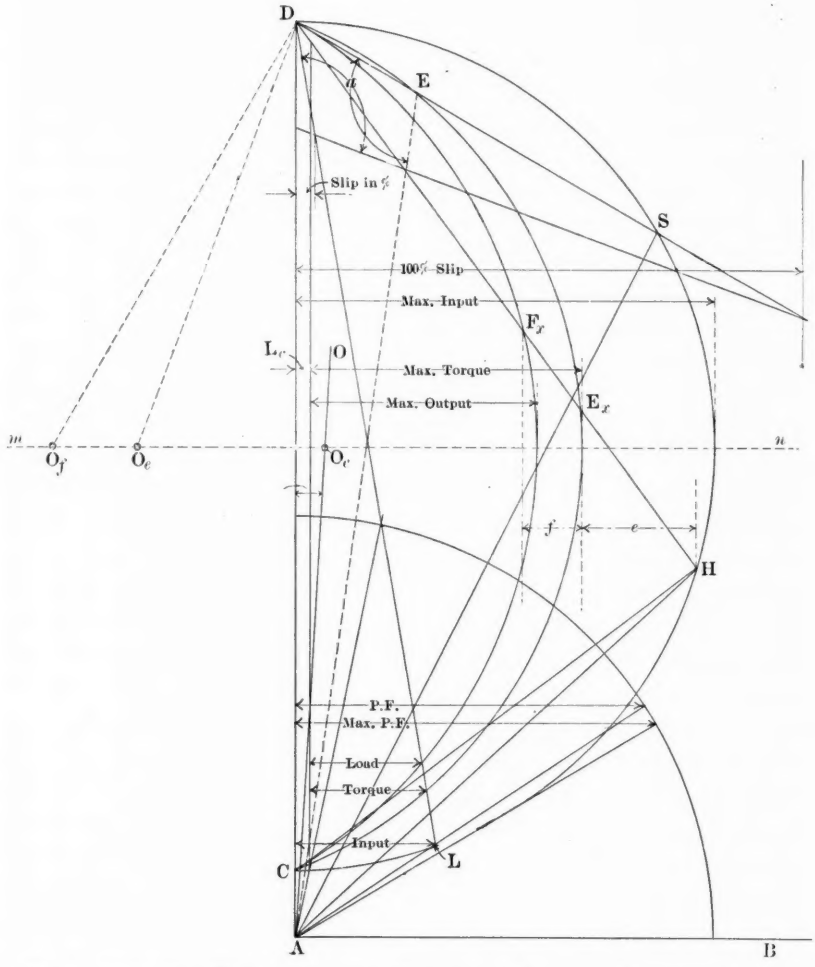


FIG. 1.—CORRECTED HEYLAND DIAGRAM USED IN THE DESIGN OF INDUCTION MOTORS.

of convenient size $= c_1$. Then we have (see Fig. 1):

$$(1)\quad AC = \frac{i_m}{c_1} \text{ and}$$

$$(2)\quad DC = \frac{c_1\, i_m\, (1-\delta)}{\delta}$$

where i_m = magnetizing current per phase and δ = leakage coefficient.

The constant of the secondary current is

$$(3)\quad c_2 = \frac{a_1\, z_1\, k_1\, f_1}{a_2\, z_2\, k_2\, f_2}\, c_1 \left(1 + \frac{\delta}{2}\right)$$

for phase-wound rotors and

[1] See *Electrical World*, November 23, 1907, page 1004.

$c_2 = \frac{a_1 z_1 k_1 f_1}{k_2} c_1 \left(1 + \frac{\delta}{2}\right)$ for squirrel-cage rotors.

Since no special definitions for the various factors in the preceding and in the following formulæ are given, the definitions given in the previous article apply: f_1 and f_2 represent the primary and secondary pitch factors respectively, the values for which may be taken from Fig. 2.

The watt-constant is

$$(4)\quad c = 3\ c_1\ E$$

The angle ϵ is found from

$$(5)\quad \sin \frac{\epsilon}{2} = \frac{i_m r_1}{E}$$

The diagram may now be constructed. Draw AD at right angle to AB and laying off AC and DC as found by equations 1 and 2, draw AC so as to make the angle ϵ between AD and AO; draw the circle CLSD so that it passes through the points A and D and so that its centre O_c is on the line AO; draw the line mn through O_c at right angles to AD. Assume any point X on the circle CLSD, preferably below the line mn. The primary current for this load point is AX x c_1 and the secondary current CX x c_2.

Knowing the primary and secondary current and the primary and secondary resistances, the primary and secondary copper losses for the load point X may be easily determined.

Draw the circle CE_xD so as to pass E_x and F_x by making the horizontal distances

$$e = \frac{\text{primary copper losses for point X}}{c}$$

and

$$f = \frac{\text{secondary copper losses for point X}}{c}$$

Draw the circle CE_xD so as to pass through the points C, E_x and D and the circle CF_xD so as to pass through the points C, F_x and D. Connect the centre O_f of the latter circle and the point D and draw the line DS at right angles to O_f D. The point S is the short-circuit point. The diagram may now be completed and used for the derivation of the motor performance as described by Heyland in "The Graphical Treatment of the Induction Motor."

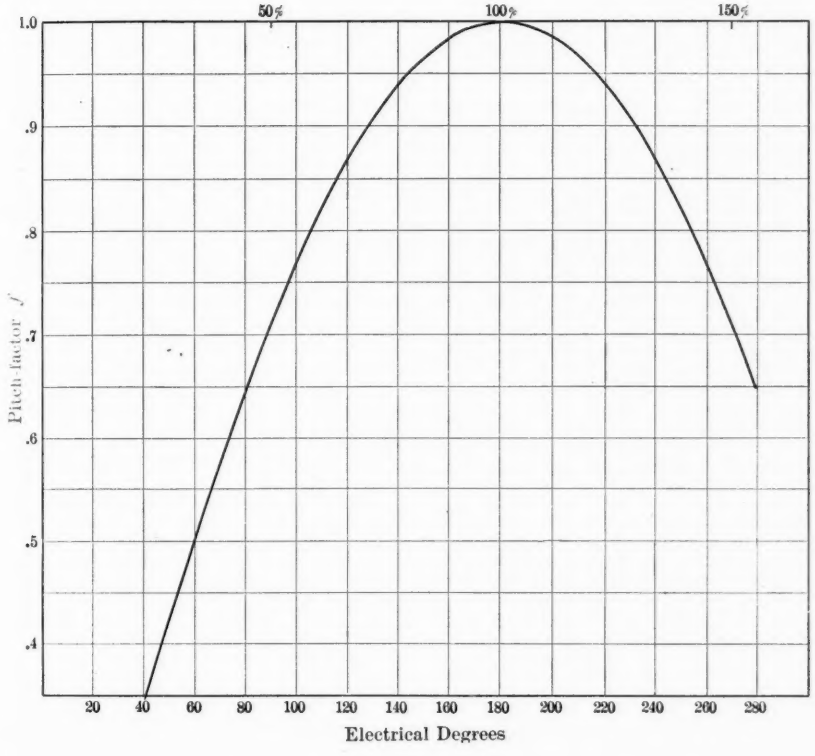


FIG. 2.—CURVE GIVING THE PITCH FACTORS FOR INDUCTION MOTOR DESIGN.

Where it is desirable to determine the efficiency more correctly than is possible by taking it directly from a diagram drawn in a small scale, the primary and secondary currents may be taken from the diagram for any load condition; then the ohmic losses may be calculated and the efficiency may be determined by the loss method. If this be done, the errors introduced by the inaccuracy of the drawing and by inexact readings of the values from the drawing are very small, since they appear in the final result only as errors of the second degree. Therefore the inaccuracy of the efficiency found by this method is practically reduced to the inaccuracy of any loss method. The slip may be determined very closely by the ratio of the secondary ohmic losses to the secondary input, which may be found from the diagram or by calculation. The power-factor values may best be taken directly from the diagram and will be correct within one per cent for motors above one horse-power, provided, of course, that the values upon which the diagram is based are correct. For reasons discussed in the previous article the maximum output, the maximum torque and the starting torque are somewhat smaller than found from the diagram; also the starting current is slightly smaller. These inaccuracies are, however, not larger than those of any other method and, as in the case of any other method of calculation, their right consideration depends largely upon the skill and experience of the designer.

Moreover, since the formulæ have been reduced to a very small number, the writer believes that the graphical method as outlined above is quite advantageous if compared with analytical methods; it will give the desired results more quickly than analytical methods in all cases where a complete motor performance is desired; the diagram gives a clear conception of the motor performance and enables the designer to see at a glance in what ways, and how much, a motor can possibly be improved; finally the comparison of calculation and test is considerably facilitated, since at present the diagram is used in the majority of cases for the experimental determination of the motor performance. The design method outlined above may, of course, be applied in a similar way to any of the possible modifications of the circle diagram.

The New York Electrical Show.

The second annual electrical show will be held at Madison Square Garden, New York city, October 3 to October 14, inclusive. The management announces that sixty per cent of the floor space was sold to the exhibitors before the close of the 1907 show.

The officers of the show are: George F. Parker, president; Dudley Farrand, secretary; Walter Neumuller, treasurer. The directors are the officers and Arthur Williams, W. W. Freeman, James R. Strong and James C. Young.

The Annual Convention of the International Independent Telephone Association.

Coliseum, Chicago, Ill., January 21, 22 and 23.

THE annual convention of the International Independent Telephone Association was held at the Coliseum Annex, Chicago, Ill., January 21, 22 and 23. There was a large attendance, every state in the Union being represented, as was Canada. Great enthusiasm was manifested in the independent movement, and apparently the business is in a very flourishing condition.

The first session was called to order by President Theodore Gary, of Macon, Mo., at 2 o'clock on the afternoon of January 21. The divine invocation was delivered by the Rev. Z. B. Phillips, of the Trinity Episcopal Church. The address of welcome was made by George W. Miller, representing the mayor of the city of Chicago, the response being made by M. L. Clawson, of Indianapolis, Ind. Mr. Clawson thanked Mr. Miller very heartily for his tender of facilities, but deplored the attitude of Chicago with regard to opening the door to independent telephone communication from other states.

The presidential address was delivered by Mr. Gary, who emphasized the importance of co-operation among all of the members and the necessity for strong work among the individual members and the state associations to perpetuate the international body.

The report of the assistant secretary, J. A. Harney, was read. This report showed that the association is in a good condition and that a small amount of material is still on hand in the supply department. Work upon the maps has been suspended, but this work is in such a condition that it can very quickly be taken up again and carried to completion. The headquarters of the association had been moved from Cleveland to Chicago on November 11 last. Thirteen per cent of the total assessments levied at the last meeting have been collected. The treasury is in good shape, showing a surplus of $4,182.43. Through the reorganization of the Pennsylvania Telephone Association, under the title of Eastern States Independent Telephone Association, Delaware, Maryland and New Jersey have been admitted to membership. This brings the total states represented in the association up to twenty-six. These twenty-six states and Canada are represented by twenty-three separate independent telephone associations. Plans are now under way for the organization of the Inter-Mountain Independent Telephone Association, embracing the states of Idaho, Utah, Montana and Wyoming. Organizations are also contemplated for a few other states.

A. C. Lindemuth, chairman of the advisory committee, presented a lengthy report, the feature of which was embodied in two resolutions looking to the raising of funds for the perpetuation of the international association. These resolutions levied an assessment of two mills per unit, a unit to consist of one operating telephone or one circuit mile of toll line operated in each state by the independent companies. No annual dues, however, should be less than $50 per state or association. The dues should be paid in full or guaranteed in writing by responsible parties from the respective states, total payment to be guaranteed by July 1, 1908. The second resolution leved a pro rata assessment upon independent manufacturers and dealers in independent apparatus, equipment, wire, cable, poles and other telephone material, and applied also to the publishers of independent telephone journals and magazines. This required that all such manufacturers, supply dealers and publishers be required to affix stamps to all invoices and bills for goods and supplies sold to independent operating companies, and to advertising and subscription bills of journals, in the proportion of one-tenth of one per cent of invoices or bills amounting to $500 or less, and one-twentieth of one per cent on all bills or invoices for amounts in excess of $500. The resolution also included penalties for non-observance of these rules, should they be carried. After considerable discussion, which was carried over into the following session, both these resolutions were adopted.

After the appointment of several committees, E. H. Moulton, of Minneapolis, Minn., read a paper entitled "The Banker's Opinion of Securities." Mr. Moulton showed why independent telephone securities should be in the nature of a first-class investment, and emphasized the importance of the operators of the company being very closely in touch with their stockholders and subscribers. He thought that capital would appreciate the conservative manner of financing which was the case with independent telephone properties, and that eventually these securities would stand at the head of the list for safe, sound investments.

The reports of states were then called for. George E. Knight, reporting for California, said that affairs in that state were in a very satisfactory condition. The Los Angeles Home Telephone Company has a large number of contracts on the waiting list, and as fast as it is able to cut in its new automatic exchanges and get additional equipment it is taking care of a rapidly increasing business.

The Canadian Independent Telephone Association, through L. Page Wilson, reported that progress in Canada during the past year had been sure and fairly rapid. In Winnipeg the Manitoba Government has already had a large part of its conduit work laid, and arrangements are being made for installing systems in the provincial municipalities as soon as possible. The province of Alberta has about 500 miles of publicly owned telephone lines connecting up a large number of the more important towns and rural communities. In Quebec the Belle Chasse Company has obtained favorable legislation from the government, and a satisfactory franchise has also been obtained from the city of Quebec. This is the first city of over 50,000 population in Canada to try a competitive system. The latest development in Manitoba is the provincial government's purchase of the Bell system. There are probably 18,000 to 20,000 independent telephone subscribers now in Canada.

C. B. Cheadle reported for Illinois. In the city of Bloomington the independent company now has 3,700 telephones in service. In the state of Illinois there are approximately 200,000 independent telephones in service.

Charles S. Norton reported for Indiana that the companies were advancing rates without any opposition developing. At Indianapolis an application for an amended franchise, allowing the company to register rates so as to collect from all consumers in proportion to the service used, has been presented. There is every prospect that this request will be granted by the city. The average number of

independent telephone subscribers for ninety-two counties in the state is 2,000.

A. C. Davis presented the report for West Virginia. This showed an entirely satisfactory growth in 1907. A great deal of new building has been done.

Frank L. Beam reported for Ohio that the independent telephone companies are operating over 307,000 telephones.

The second session of the convention was called to order Wednesday morning at 10 A. M., President Gary in the chair. The first order of business was the adoption of the two resolutions concerning the raising of funds, mentioned heretofore.

The report of the credentials committee was presented, and after considerable debate, in which several amendments were made with regard to the voting classification of the members, was adopted.

The reading of reports from states was continued. E. B. Fisher, reporting for Michigan, stated that, in a general way, the condition in Michigan has been very gratifying. It is expected that before the first of April a first-class independent exchange will be established in Detroit. The company can not commence charging under its contract until 7,000 telephones are in service. It is now installing telephones at the rate of 100 or 200 a day, and expects soon to be able to charge. The company has secured 16,000 contracts for service in that city.

W. S. Vivian, president of the Michigan State Independent Telephone Association, and president of the Michigan State Traffic Association, stated at this time that there were 86,000 independent telephones and about 11,000 miles of pole lines, sixty per cent of which were copper, working in Michigan. In connection with the traffic association, every independent company in that city is directly or indirectly allied with the association. The traffic association is clearing to-day about 21,000 messages per month at a cost of one and two-fifths cents per message. The managers' association has a membership of something over 100 of the more important managers throughout the state.

Charles West reported for Pennsylvania upon the organization of the Eastern States Independent Telephone Association, consisting of Pennsylvania, New Jersey, Maryland and Delaware. No statistics are ready for the three latter states, but in Pennsylvania there are now 200,000 independent telephones, 385 exchanges, 2,875 pole stations, 25,000 miles of pole lines and 100,000 miles of circuit.

G. W. Schweer reported that Missouri has about 175,000 independent telephones. Many new connections were made during the past year. The district association meetings have been a great success, and much good was accomplished in each district.

H. D. Critchfield reported that there are approximately 52,000 telephones installed in Wisconsin at the present time. An independent system will be built in Milwaukee this spring. Money has now been provided, and the work will be done as soon as the weather will permit.

R. Max Eaton reported for the state of New York. There are, in thirty-nine counties out of a total of fifty-five in New York state, not including New York city and Long Island, 123,000 independent telephones.

Frank G. Hoge reported that Kentucky has something like 22,000 independent telephones in operation. In Kentucky the lowest rate is $1.50 per month for a party line. This runs up sometimes as high as $3.

Photo by Moffett, Chicago.

A. C. LINDEMUTH, INDIANA,
President, 1908-9, International Telephone Association.

J. A. Zimmerman reported that the estimate in Kansas six months ago was 45,000 independent telephones and about 5,000 miles of toll line.

H. W. Buchanan reported that in Vermont and New Hampshire the independent companies were doing a good business and paying interest on the investment.

H. D. Houck, of Harrisburg, Pa., addressed the convention and emphasized the importance of the association's raising a considerable amount of money so that a concerted effort could be made toward improving the whole independent situation.

Considerable discussion resulted from Mr. Houck's address, and a number of members suggested ways and means by which this fund could be secured. James S. Brailey stated that he thought it would be hard work to get individuals to guarantee $10,000. He thought the association should start out next year with $12,500, and was willing to guarantee ten per cent of any deficit which might accrue in receiving this fund. This suggestion was received with great favor, and subsequently the members pledged their companies not only for the full payment of their dues for the coming year, but subscribed something like 150 per cent of any deficit which might accrue in securing $12,500.

G. E. Becker reported for Nebraska that there were 50,000 independent telephones in service, and that the companies were in good financial shape. The independent companies have about 7,000 circuit miles of long-distance telephone service, and have a clearing-house arrangement which nearly all of the larger operating companies actively support.

The convention was called to order on Thursday morning, January 23, at 10.30, with President Gary in the chair. The invocation was delivered by the Rev. Jenkin Lloyd Jones.

The first business was the reading of a paper by J. H. Shoemaker, entitled "The Business End of the Business."

Mr. Clawson reported that the secretary of state at Springfield, Ill., had duly returned and filed in Cook County, Ill., the incorporation papers of the International Independent Telephone Association, establishing it as a regularly incorporated body.

At this session the idea of the association's raising a fund was amended so as to bring the total amount up to $15,000. The various members signed for their companies, and then listened to an address by George W. F. Gaunt on "Why the National Grange Favors Competition." Mr. Gaunt represented a national farmers' organization with about 1,000,000 members, scattered all over the country. He stated that his association greatly appreciated the efforts of the competing companies in establishing rural communication. This was a great help to the farmer and made home life on the farm more interesting and brought about numerous comforts, which were greatly appreciated.

R. Max Eaton read a paper entitled "The Solution of the Telephone Situation."

This was followed by a paper by W. H.

Denlinger, entitled "The Independence of the Independents."

Mr. Denlinger emphasized the importance of realizing the exact status of independence in operation. The spirit of independence must not carry the companies to a point where it is not recognized that they are dependent upon others for support and success. Every company is dependent upon the public for patronage and for financial support.

A debate was then indulged in on the matter of amendments to the constitution and by-laws. Other than some changes in phraseology and minor suggestions and substitutions, the constitution remains as adopted.

The report of the nominating committee was adopted unanimously as follows:

President, A. C. Lindemuth, Indiana.

First vice-president, P. C. Holdoegel, Iowa.

Second vice-president, E. B. Fisher, Michigan.

Third vice-president, J. F. Demers, M.D., Quebec, Canada.

Fourth vice-president, Arthur Wright, California.

Secretary, J. B. Ware, Michigan.

Treasurer, Manford Savage, Illinois.

The new officers were introduced to the convention, and after the usual felicitations it was regularly moved and carried that the stamp act, which had been previously endorsed, become effective at 12 o'clock that night.

The convention was then adjourned.

On Wednesday evening, January 22, the International Independent Telephone Association tendered a smoker and entertainment to a large number of delegates and guests. After the entertainment light refreshments were served.

Among the functions which were observed during the second week of the Electrical Show was a smoker and vaudeville performance tendered to the exhibitors on Tuesday evening, January 21, by the Electrical Trades Exposition Company. A well-prepared programme of high-class vaudeville was the feature. Light refreshments were served after the entertainment.

The Sons of Jove held a rejuvenation on Monday evening, January 20, in the Coliseum Annex. Thirty new members were accepted, and refreshments were served and an address made by W. L. Robertson, Jupiter, after the formal business of the meeting.

New York State Electrical Contractors.

The Electrical Contractors' Association of New York State held a meeting on January 23 at Rochester, N. Y., and wound up the session with a dinner at the Rochester Club, at which the officials of the Rochester Railway and Light Company and the Rochester Fire Underwriters' Association were guests. Among those present from the railway and electric light company were: General Manager R. M. Searle, Assistant General Manager J. T. Hutchins, T. H. Yawger, Charles N. Pratt, W. B. Colgate and Manager George L. Colgate, of the Eastern Monroe County Electric Light Company. From the underwriters were Manager J. N. Elwood and Inspectors William H. McDonald, Burton A. Vandy and J. E. Putnam. The delegates present included the following: Buffalo, J. C. Sterns, E. D. McCarthy, J. D. Robertson, J. J. O'Leary; Eastern association, Marshall Barnes, of Troy; James T. Burns, of Schenectady; P. M. Bulloch, of Albany; New York, A. A. Nimms, James R. Strong, E. A. Keefer, A. J. Martin; Independent New York Association, Emil Christesen; Syracuse, Edward Joy, J. H. Gough, Robert Hanlon, E. E. McKenzie; Rochester, Rudolph Schmidt, James McDonnell, Fred Fish, Henry Meach, Thomas H. Green, E. C. Sykes and M. S. Horton.

The next meeting of the association is to be held in Syracuse in July.

Western Electric Stock Deposits.

The amount of stock deposited in accordance with the offer of the American Telephone and Telegraph Company to stockholders of the Western Electric Company, says the *Wall Street Journal*, to purchase their holdings, paying therefor in bonds or cash, will not vary materially from 30,000 shares or, say, fifty per cent of the 59,679 shares of minority stock outstanding, a result which the management of the American Telephone and Telegraph Company states is as satisfactory as anticipated. The parent company will now control eighty per cent instead of sixty per cent of Western Electric as formerly.

At some later date negotiations may be begun again with minority stockholders for their holdings.

The $15,000,000 five-per-cent bonds which the Western Electric has in its treasury will be sold only when conditions warrant their sale at a satisfactory price. The company is in strong cash position, and the indebtedness which will be retired from the proceeds of the bonds can be safely left in its present form until the directors see fit to sell the bonds.

The National Board of Fire Underwriters' Committee on Rheostats.

At the annual meeting of the National Board of Fire Underwriters, held last spring, a subcommittee on rheostats was appointed to consider proposed amendments to the National Electrical Code. All other sections were discussed and amendments settled at the spring meeting, but the section pertaining to rheostats was omitted with the idea of taking this matter under consideration and to give the manufacturers an opportunity to formulate suggestions for changes and revisions. On January 28 a meeting of the Committee on Rheostats of the National Board of Fire Underwriters was held in the rooms of the Underwriters in New York city. Among those represented were the following companies: General Electric Company, Western Electric Company, Automatic Switch Company, Cutler-Hammer Manufacturing Company, Westinghouse Electric and Manufacturing Company, Ward Leonard Electric Company and Otis Elevator Company. The matter under consideration was the amendment of Article 64, Section H, of the National Electrical Code.

After considerable debate an amendment was unanimously adopted, which was in substance that all rheostats be tested to destruction so as to prevent molten metal from fused resistance conductors flowing or dropping outside of the rheostats. All the rheostats under test should withstand a twenty-five per cent overload throughout the resistance length, or such part of it as may be available for full-load conditions; or the rheostat should withstand a twenty-five per cent overload for five minutes.

The question of temperature coefficient was thoroughly discussed, and the consensus of opinion was that this should be as low as possible.

The question of enclosing all rheostats was also discussed.

The proposed amendment is in the nature of a suggestion from the manufacturers, and must first be approved by the Committee on Rheostats, of which George N. Bruen is chairman, before being accepted by the Electrical Committee for discussion and its later incorporation in the National Electrical Code.

THE HEAT CONDUCTIVITY OF IRON STAMPINGS.[1]

BY THOMAS MORGAN BARLOW.

The main object of the research undertaken was to determine, 1, the conductivity of heat in a direction parallel to the insulated iron stampings, and, 2, the conductivity in a direction at right angles to the plane surface of the stampings, *i. e.*, across iron and paper (insulation).

No attempt was made to use artificial cooling by oil or forced draft, as the method employed did not lend itself to air cooling other than by the natural convection currents in the air.

Consider the case of a lamina or wall with parallel faces. One face kept at a fixed temperature θ_1 while the other is maintained at θ_2. If there be established a permanent state and uniform flow of heat the temperature may be taken to fall uniformly if the wall be made of the same material throughout, and if the conductivity does not depend upon the temperature.

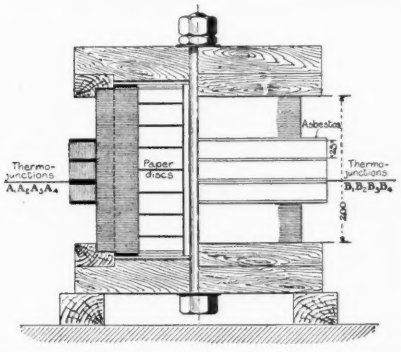


FIG. 1.—SECTION AND ELEVATION OF APPARATUS FOR MEASURING HEAT CONDUCTIVITY OF IRON STAMPINGS.

From the first principles, the quantity of heat which flows through such a wall is directly proportional to the difference of temperature $(\theta_1 - \theta_2)$ of its faces. The quantity of heat which flows through an area A of such a wall in time t seconds will be proportional to A and t, also if Q be the quantity of heat, a the thickness of the wall, and K be the heat conduction coefficient depending upon the nature of the substance and numerically equal to the quantity of heat which flows per unit time through unit area of a plate of unit thickness having unit difference of temperature between its faces then—

$$Q = K \cdot \frac{\theta_1 - \theta_2}{a} A\, t.$$

(The units in all calculations are centigrade and centimetre-gramme-second.)

If the plate has an infinitely small thickness dx and an infinitely small temperature difference $d\,\theta$, then the quantity of heat which flows through it in a small time dt is—

$$d\,Q = KA \frac{\theta - (\theta + d\,\theta)}{dx} dt. = - KA \frac{d\,\theta}{dx} dt,$$

or when the steady state has been reached—

$$- d\,\theta = \frac{1}{K} \cdot \frac{Q}{A} dx. \qquad (1)$$

Now consider the flow of heat through a circular lamina heated from the inside. This corresponds to the actual case of the experiment. Let the temperature at a distance r centimetres from the centre be θ_r and at a radius $x + r$ be θ_x. For a distance dx and a temperature difference $d\,\theta$ from equation (1)—

$$- d\,\theta = \frac{1}{K} \frac{Q}{A} dx.$$

Therefore at a radius $(x + r)$—

$$- d\,\theta = \frac{1}{K} \frac{Q}{2\,\pi\,(x + r)} d\,(x + r)$$

at radius r—

$$- d\,\theta = \frac{1}{K} \cdot \frac{Q}{2\,\pi\,r} dr,$$

i. e., by integration—

$$- \theta_x = \frac{1}{K} \cdot \frac{Q}{2\,\pi} \cdot \log_e (x + r) + C_1,$$

and—

$$- \theta_r = \frac{1}{K} \cdot \frac{Q}{2\,\pi} \log_e (r) + C_1.$$

Therefore—

$$\theta_r - \theta_x) = \frac{1}{K} \cdot \frac{Q}{2\,\pi} \log_e \left\{ \frac{x + r}{r} \right\}.$$

If the temperature difference between the two points be denoted by θ, then—

$$\theta = \frac{1}{K} \cdot \frac{Q}{2\,\pi} \cdot \log_e \left(1 + \frac{x}{r}\right).$$

If l centimetres be the length of a cylinder built up of stampings or laminæ, the surface of the cylinder being the total cooling surface, then— .

$$\theta = \frac{1}{K} \frac{Q}{2\,\pi\,l} \cdot \log_e \left(1 + \frac{x}{r}\right) \qquad (2)$$

From this formula the values of K for iron stampings, both in the direction parallel to the plane surface of the stampings and across the iron and paper at right angles to the surface, were calculated.

If K_a be the heat conduction coefficient for iron laminations in a direction parallel to the surface of one stamping, and K_b in a direction at right angles to this surface, *i. e.*, across iron and paper or insulation, then their ratio $= \frac{K_a}{K_b}$.

If C equals the ratio of the sides of two square surfaces, one being the edge surface of a packet of stampings and the other being the plane surface of the outside stamping of the packet, and if both these surfaces are made to dissipate the same amount of heat, *i. e.*, equal cooling, then—

$$C = \sqrt{\frac{K_a}{K_b}}.$$

To obviate the difficulty of calculating the heat leakage if the iron stampings were heated on one side, a cylinder built up of stampings was used, being heated on the inside edge and cooled on the outside (see Fig. 1). This was built up of stator stampings 0.0345 centimetre thick, and insulated with a preparation known as "Insuline." The plates were firmly clamped together, and the slots wound with ten turns of double cotton-covered copper wire round each tooth, giving twenty turns per slot. The slots were insulated with paper tubes built up by rolling cartridge paper stuck with shellac varnish round a former. The thermo-junctions for the core were fixed between two fine sheets of condenser paper cut to the same shape as the stampings, the two leads of each junction being carefully brought out so that there was no fear of short-circuit. The stampings were clamped together between two wooden rings by means of a bolt and two heavy cross-pieces. The wooden rings were insulated with asbestos from the iron stampings. To prevent the iron bolt from getting hot and so allowing the nut and head to dissipate heat, the air inside was divided off into sections, so as to localize the heat currents by means of discs of paper. The bolt was also shielded by a paper tube. The top and bottom of the core were insulated also with absestos sheet, cord and cotton waste. These precautions practically ensured that all the power supplied to the windings would be

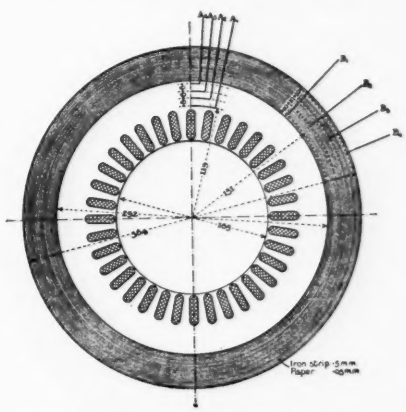


FIG. 2.—METHOD OF ARRANGING AND LEADING-OUT THERMO-JUNCTION LEADS.

[1] Abstract of a paper read recently before the Institution of Electrical Engineers of Great Britain.

dissipated in heat from the outside edge surface of the stampings.

For the second part of the work, *i. e.*, the measurement of the heat conductivity across iron and paper, iron strip was wound over the outside of the cylindrical core, each layer being interleaved with paper. The strip was 2.5 × 0.05 centimetres, and was of best soft steel of bluish color. The paper was 0.005 centimetre thick. Three coils were wound, the thermo-junctions being placed at suitable intervals in the centre one, the two outside rings acting as guard rings. The coils were insulated with asbestos sheet from each other, and the edges of the two outside coils were also insulated from the air with asbestos sheet rings.

Some difficulty was experienced in winding the iron strip on tight, and in one case the coil had to be rewound owing to a thermo-junction being broken due to tightening. The position and method of carrying away the leads of the thermo-junctions are shown in Fig. 2. In the core A_1, A_2, A_3, A_4 were placed eight millimetres apart. In the strip B_1, B_2, B_3, B_4 were ten millimetres apart, giving a total distance between A_1 and A_4, B_1 and B_4, of 2.4 centimetres and three centimetres respectively. After the strip had been wound on it was found that A_3 and B_3 had become short-circuited or broken. As this could not be remedied without dismantling the whole apparatus, readings were only taken from the six remaining thermo-junctions, these being quite sufficient for calculating the results required.

The measurement of the temperature by electrical resistance thermometers[1] (*i. e.*, the temperature calculated from the variation of the resistance of embedded coils), was impracticable in this experiment, owing to the depth of leads to the coils, which would be embedded in the iron, being also subjected to a variation which would need an assumed temperature drop to be allowed for.

As the temperature was only to vary from 15-80 degrees centigrade, a new combination of metals was tried for a thermo-junction, and was found to give a straight line between the above limits. The two junction wires were—

Positive (+), No. 40 German silver silk covered.

Negative (—), No. 32 pure silver wire bare.

The silver wire was absolutely virgin silver. The actual junction was made by twisting the ends for about 0.3 centimetre and dipping in silver solder. The junction was then flattened by light taps.

The experiments were conducted in a room free from drafts and kept as near as possible at a uniform temperature, so that the temperature of the cold junctions would remain constant. The tempera-

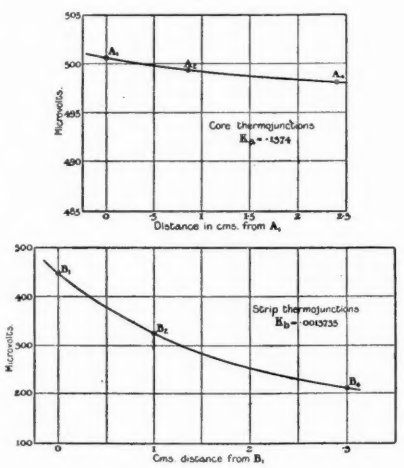


FIG. 3.—TEMPERATURE CURVES (TEST 6).

tures were determined by means of a polentrometer and calibration curves of the junctions. Care was taken to keep all junctions and connections free from any drafts and no readings were taken for fifteen minutes after any connection

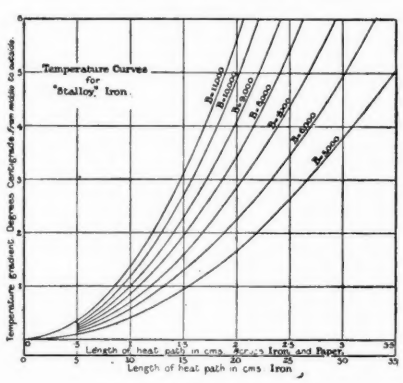

Temperature Curves for "Stalloy" Iron.
Temperature gradient. Degrees Centigrade from middle to outside
Length of heat path in cms. Across Iron and Paper
Length of heat path in cms. Iron

FIG. 4.

had been touched. This allowed everything to settle down to its normal temperature.

THEORETICAL CALCULATION OF THE CONDUCTION COEFFICIENT ACROSS IRON AND PAPER FROM THE VALUES FOR IRON (K_1), PAPER (K_2) AND AIR (K_3).

Consider the flow of heat across one lamina of iron and one of paper in a direction at right angles to the surface. If Q be the total amount of heat across both iron and paper, θ the total drop of temperature, and K_b be the conduction coefficient for iron and paper interleaved, d_1 thickness of iron, d_2 thickness of paper, then—

$$Q = \frac{K_b\,\theta}{d_1 + d_2}.$$

If Q_1 and θ_1 are the amount of heat and the temperature drop respectively across the iron lamina, and Q_2 and θ_2 the values for paper, then—

$$Q_1 = \frac{K_1\,\theta_1}{d_1} \text{ and } Q_2 = \frac{K_2\,\theta_2}{d_2}.$$

Therefore, since $Q = Q_1 + Q_2$

$$\therefore \frac{K_b\,\theta}{d_1 + d_2} = \frac{K_1\,\theta_1}{d_1} + \frac{K_2\,\theta_2}{d_2},$$

$$\therefore \frac{d_1 + d_2}{K_b} = \frac{d_1\,d_2\,(\theta_1 + \theta_2)}{K_1\,\theta_1\,d_2 + K_2\,\theta_2\,d_1};$$

and—

$$\theta = \theta_1 + \theta_2;$$

$$\therefore \frac{d_2 + d_2}{K_b} = \frac{d_1}{K_2} + \frac{d_2}{K_2} + \left\{\frac{\frac{K_1}{K_2}\,\theta_1\,d_2^2 + \frac{K_2}{K_1}\,\theta_2\,d_1^2}{K_1\,\theta_1\,d_2 + K_2\,\theta_2\,d_1}\right\}$$

$$= \frac{d_1}{K_1} + \frac{d_2}{K_2} + \left\{\frac{K_1^2\,d_2^2\,\theta_1 + K_2^2\,d_1^2\,\theta_2}{K_1^2\,K_2\,\theta_1\,d_2 + K_2^2\,K_1\,\theta_2\,d_1}\right\}$$

The expression in the brackets can be neglected since d_2^2 and K_2^2 are very small quantities; approximately—

$$\therefore \frac{d_1 + d_2}{K_b} = \frac{d_1}{K_1} + \frac{d_2}{K_2}.$$

If we reckon that the iron and paper do not fill the entire distance, but have very small layers of air between (this is actually the case), and if K_3 and d_3 are the conductivity and thickness of air, then similarly—

$$\therefore \frac{d_1 + d_2 + d_3}{K_b} = \frac{d_1}{K_1} + \frac{d_2}{K_2} + \frac{d_3}{K_3} \quad (1)$$

In the experiment—

$d_1 = 0.05$ centimetre.

$d_2 = 0.005$ centimetre.

$d_3 = 0.00125$ centimetre.

(d_3 is worked out from the fact that fifty-three laminæ of iron and paper took up a distance of three centimetres).

The following are values of K used for iron, paper and air (C.G.S. centigrade units):—

K_1 Iron....0.1528 at 28 degrees centigrade (Hall).[1]

K_2 Paper....0.0003 (Lees).[2]

K_3 Air....0.0000479 at zero centigrade (Compan).[3]

From the formula for variable conductivity $K = K_0\,(1 + a\,t)$ the correct conductivity was calculated for the approxi-

[1] Journal, Institution of Electrical Engineers, vol. 34, p. 613, 1905. Report on Temperature Experiments, National Physical Laboratory (Rayner).

[1] E. H. Hall, *Physical Review*, vol. 10, p. 277, 1900.

[2] Ch. Lees, *Phil. Trans.*, vol. 183A, p. 481, 1892.

[3] P. Compan, *Comptes Rendus*, vol. 133, pp. 120-2, 1901.

mate temperatures. The values of a being—

— 0.000282..Lorenz for iron.[4]

+ 0.0013....Compan for air.[4]

This gives the value of K_1, K_2 and K_3 at the approximate temperature of the experiment, *i. e.*,—

$$K_1 = 0.152.$$
$$K_2 = 0.0003.$$
$$K_3 = 0.0000528.$$

From formula (1) the theoretical value of K_b from these figures is—

$$K_b = 0.00138.$$

Constants for the Experiment in Formula for Temperature Difference—In the formula—

$$\theta = \frac{1}{K} \cdot \frac{Q}{2\pi l} \log_e \left(1 + \frac{x}{r}\right) \quad (2)$$

the constants for the two tests for K_a, K_b, respectively, are the values of x and r, and for both l is taken as constant.

In this case, $x = 2.4$ centimetres and $r = 11.9$ centimetres. In both cases $l = 20$ centimetres.

Then—

$$\theta_a = \frac{1}{K_a} \frac{Q}{125.67} 0.1825.$$

If P = watts lost, then P = 4.18 Q (Q being in centigrade C.G.S. units);

$$\therefore K_a = \frac{P}{\theta_a} . 0.0003476.$$

Similarly for K_b—

$x = 3$ centimetres,

$r = 15.1$ centimetres,

$l = 20$ centimetres,

the temperature drop being θ_b.

Then—

$$K_b = \frac{P}{\theta_b} . 0.0003439.$$

From table I of results the average values obtained are—

$$K_a = 0.1405,$$

and—

$$K_b = 0.00137.$$

This gives an average value of C of 10.1. Hence the ratio of sides of square edge and plate surfaces of iron stampings for equal cooling averages about ten. In actual practice the pressure on the stampings would be slightly more than that used in the experiment. This would lower the value of C by raising K_b a little.

The temperature-drop curves shown in Fig. 3 are for Test 6.

CALCULATION OF CURVES FOR TEMPERATURE RISE IN IRON STAMPINGS FROM THE VALUES OF K_a AND C.

Consider the case of a packet of iron stampings heated internally by (we may suppose) hysteresis and eddy currents.

Let the temperature at a mid-point distance t from either face be θ_2, and θ_1 be temperature at outside surface, then $\theta = \theta_2 - \theta_1$.

Consider an element distance x from ab having a cross-section of one square centimetre. The element has a temperature difference of $d\theta$ and a volume of x c.cms. Then heat transferred between $x = 0$ and $x = x$ is $\frac{d\theta}{dx} . K_a$ after a steady state has been reached.

But the heat transferred equals the heat generated. Also the heat generated in x c.cms. $= f(x) = \lambda x$.

$$\therefore \frac{d\theta}{dx} K_a = \lambda x$$

where λ = calories per cubic centimetre—

$$\therefore \frac{d\theta}{dx} = \frac{\lambda x}{K^a}.$$

Integrating—

$$[\theta]_{\theta_1}^{\theta_2} = \left(\frac{\lambda x^2}{2 K_a}\right)_o^t$$

$$\therefore \theta = \frac{\lambda t^2}{2 K_a}.$$

λ depends upon the induction frequency and thickness of the iron plates. Therefore curves can be drawn for various inductions showing the temperature gradient for any length of heat path, both in a direction parallel to the iron stampings, and in a direction at right angles—that is, across iron and paper since $C = \sqrt{\frac{K_a}{K_b}}$ is known. The value of P_i — *i. e.*, watts lost per kilogramme corresponding to any particular induction—are taken from tables published by Sankey & Sons for their "Stalloy" iron stampings 0.35 millimetre at fifty cycles.

B (Lines per Cm.²) (Induction).	P_i (Watts Lost per Kg.).
5,000	0.64
6,000	0.84
7,000	1.08
8,000	1.32
9,000	1.56
10,000	1.87
11,000	2.15

METHOD OF CALCULATING θ FOR VALUES OF B.

From the table we can obtain the loss in watts per kilogramme = to P_i.

This reduced to calories per cubic centimetre $= \lambda = \frac{P_i}{540}$.

$$\therefore \theta = \frac{P_i}{540} \cdot \frac{t^2}{2 K_a}.$$

K_a average value = 0.1405—

$$\therefore \theta = \frac{P_i t^2}{152}.$$

The curves in Fig. 4 are applicable to the flow of heat across iron and paper by using the top scale, which is one-tenth time the bottom scale, C being taken equal to ten.

DETERMINATION OF COOLING CONSTANTS WITH STILL AIR AND MODERATE AIR BLAST, FOR IRON STAMPINGS (EDGES ONLY).

After the completion of tests as above the iron strip and paper were removed. The core was then heated up to various degrees and the temperature noted by means of the thermo-junctions. Two series of tests were conducted: (1) Still air cooling, (2) moderate blast cooling. The latter was obtained by sending a blast from an ordinary ventilating fan round the core.

Then if P watts be supplied to heat the core and S be the cooling surface in square centimetres then the specific cooling surface σ (defined as the number of square centimetres allowed per watt) $= \frac{S}{P}$.

TABLE I.

CONDUCTIVITY TESTS.

Number of Test.	Watts to Heat Core = P.	Temperature θ_a.	Temperature θ_b.	Temperature of Cold Junction.	K_a.	K_b.	$\frac{K_a}{K_b}$.	C.
1	122.8	0.2900	31.98	17.40	0.1470	0.0013210	111.0	10.53
2	140.0	0.3300	34.80	17.51	0.1471	0.0013820	106.0	10.30
3	121.0	0.2949	30.09	16.55	0.1430	0.0013900	103.0	10.16
4	81.1	0.2040	20.10	16.50	0.1376	0.0013820	99.5	9.98
5	68.5	0.1735	17.10	15.55	0.1371	0.0013790	95.6	9.79
6	75.2	0.1900	18.81	15.55	0.1374	0.0013735	100.0	10.00
7	92.8	0.2330	24.05	15.80	0.1380	0.0013250	104.0	10.20
8	99.3	0.2495	24.50	15.46	0.1381	0.0013920	99.2	9.97
9	108.0	0.2690	26.95	15.40	0.1390	0.0013800	100.7	10.03
10	117.5	0.2750	27.60	17.90	0.1410	0.0013920	101.2	10.06

TABLE II.

COOLING COEFFICIENTS.

P. Watts to Heat Core.	Temperature Rise T.		σ Specific Cooling Surface	C. Still Air.	C. Moderate Air Blast.
	Air Cooled.	Moderate Blast.			
40.95	16.70	5.55	45.00	750	250.0
73.60	26.87	10.10	24.95	670	252.5
59.50	22.60	8.97	30.90	700	277.0
147.10	48.70	27.60	12.45	602	344.0
95.60	34.50	15.10	19.20	665	290.0
49.40	19.68	....	37.20	735	....
118.10	41.60	....	15.55	645	....

[4] Landbolt-Bornstein, *Physikalisch-Chemische Tabellen.*, Tab. 173.

The temperature rise can then be expressed approximately by the formula—

$$T = \frac{C}{\sigma}$$

when C is a coefficient. If C were constant a curve showing the variation of temperature with the specific cooling surface would be a hyperbola. The coefficient, however, varies slightly, but for ordinary calculations the value for C, which gives a hyperbola closely approximating to the actual cooling curve, may be taken. The curves (Fig. 5) are drawn from Table II. The hyperbolas drawn are the nearest to the two curves for cooling by still air and moderate blast. Their equations are:—

$$\text{Still air} \ldots\ldots\ldots T = \frac{650}{\sigma}.$$

$$\text{Moderate air blast } T = \frac{300}{\sigma}.$$

It will be noticed that for still air the theoretical hyperbola does not lie very well on the curve obtained by experiment. This is due to the convection currents which are set up in the still air by the dissipation of the heat. In the case of the strong air blast these have no effect. Hence the theoretical hyperbola, $T\sigma = 300$, more closely approximates to the actual curve obtained.

SUMMARY OF RESEARCH.

The main conclusion to be drawn from the values of the heat conductivities of iron insulated stampings found for a heat path (1) in a direction in the same plane as the plate surface of the stampings, and (2) in a direction at right angles to the stampings (across iron and paper), is the importance which must be given to the amount of edge surface of the stampings of a laminated iron core exposed to the cooling medium, either air or oil.

It is seen from Fig. 4, which may be drawn for any iron stampings of which the hysteresis and eddy current losses are known, that the temperature gradient will be almost a straight line in a direction with the plane of the stampings. Thus the internal temperature of the core is quickly reduced if the method of cooling employed, either air or oil, is used on this edge surface. On the other hand, if the iron laminated core is only cooled on the plate surface, the temperature will rise, comparatively, very rapidly as the core is penetrated across the iron and paper. This rise amounts to as much as five degrees centigrade for a distance of two centimetres for an induction of 10,000 lines per square centimetre at fifty cycles in the iron for which the curves are plotted. The effect of this steep temperature gradient in an iron core thus cooled is the increase of the hysteresis loss in the centre portion due to the decrease of the permeability of the iron with the rise of temperature. Also for any iron rectangular laminated core, which is heated internally, from the values of $C = \sqrt{\frac{K_a}{K_b}}$ (the ratio of the linear dimensions of the sides of the core, *i. e.*, edge side to plate side) for the most efficient cooling must equal 1:10. This ratio is somewhat higher than is used at present in common practice, the figure averaging about 1:6 for small armature cores and transformers and 1:7.5 for large cores.

Further, dealing with the question of the ventilation of direct-current armatures, it will be noticed that the ventilating ducts between the packets of iron stampings are not so useful on account of the extra plate surface exposed to the cooling draft induced, but act more as an outlet for the air inside the centre space of the armature, which has been heated in cooling the inside edge surface and so the internal parts of the core. This also applies to the ducts in large transformer cores cooled by a direct air blast.

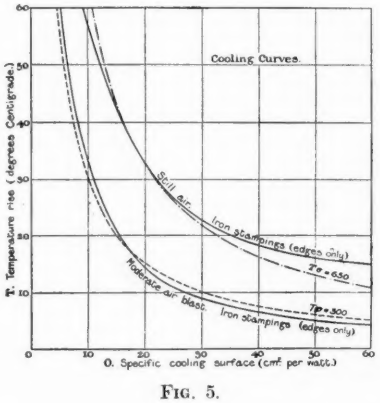


FIG. 5.

In connection with the few tests for cooling coefficients for iron cores, these formulæ may be used for the temperature rise (surface) of the iron core of a transformer, where the effective plate surface for cooling, in comparison with the edge surface, can be neglected. Values of the coefficient may be approximated for different rates of air cooling, but further work is necessary on this part of the work before any definite conclusion can be inferred.

The Use of Ball Bearings on Electric Motors.

Although there are many reliable types of ball bearings, says the *Electrical Review*, London, January 10, bearings of this kind are seldom used on motors, although they are very suitable for this purpose. Some of the advantages obtained by adopting this type of bearing are discussed here, the first being that the short length of the ball bearing makes it possible to decrease considerably the length of the armature shaft and the frame of the machine. A lighter machine is thus secured, and one which requires a smaller packing case. There is no appreciable wear of a properly made ball bearing. For this reason this type of bearing is particularly suitable for induction motors where a small air-gap is desirable. Lubrication is a simple matter, as grease is generally used instead of oil, and the bearings need looking after only every few months. With bearings of this type the oil does not clog, nor is it thrown out on neighboring objects. The bearings also are particularly suitable for shipboard use, where lubrication is sometimes difficult. Another advantage, particularly for induction motors, is the low frictional resistance at starting. The gain in efficiency is also worth considering. This may amount to one per cent of the output of the machine. Although the cost of such bearings varies, at present it is higher than that of the ordinary bearings, but if they were used in large quantities they would probably not be more expensive. When it is necessary to take up thrust, a special type of ball bearing may be used. Bearings of this type are suitable for all speeds from a few hundred revolutions per minute to ten or twelve thousand, and from the smallest shafts up to those from four to six inches in diameter. Ball bearings have been fitted to ventilating fans weighing fifteen tons, with a peripheral speed of 330 feet a second, and have given satisfactory service. When using such bearings it is essential that the balls be corrected. Not only must each one be perfectly spherical, but they should all be exactly the same size. Data are given then for the proper size of balls for bearings. The safe load on the ball is given by the formula $44\ D^2$, where D is the diameter of the ball in eighths of an inch. It should be borne in mind, however, that the load is related to the speed at which the bearings run, and should be decreased as the speed is increased. Descriptions of several types of bearings are given, some of them being combination bearings which take up end thrust of the shaft. Bearings of this type are particularly suitable for machines with vertical shafts, as there is then no difficulty whatever in providing ample lubrication.

Electrical Exposition of Marseilles.

During the next spring and summer there will be held an electrical exposition at Marseilles, which is to be carried out on an extensive scale and will be a show of exceptional interest. It is backed by the French Government, the Paris Chamber of Commerce, as well as the representative corps of the electrical and other industries. It will be held in a large area at Marseilles, which is known as the Park of the Prado, this space being an attractive one and covering about sixty acres. Here is already erected the Grand Palace, which was built at the time of the Colonial Exposition in 1906, and there are now in course of erection a number of other buildings for the show. The main object in holding the present exposition lies in the great development of the electrical field in the Mediterranean region of France. This region enjoys some exceptional advantages, seeing that the coast Alps district lying near the Mediterranean has an abundant supply of water power, and at the same time there are a number of large centres, such as Marseilles, Nice, Monte Carlo, Cannes and others, lying near by, whence a large consumption of current is taken from the hydraulic plants. At present there are many hydraulic plants erected, mainly under the control of the Energie Electrique Companie, whose power lines cover a wide extent of country, and are interconnected to form a vast network. Thus not only the large towns but the smaller localities can now use current. What is needed at present is to introduce motors and other apparatus so that the public can take advantage of this cheap and extensive supply, and this will be a good move in favor of the electrical trade. Hence the idea of holding the Marseilles exposition, which will be one of the largest collections of electrical devices which has yet appeared, as well as a most modern one. Generating groups will not be set running, but current will come from outside stations. The apparatus includes lighting, motors, traction, household uses, agriculture, mining, army and navy use, telegraphs and telephones, electrometallurgy, etc. There will be some fine buildings erected, such as the Power Palace, which, like the Grand Palace already erected, will have 7,000 square yards area. There are also the Traction and Mines Palace of 6,000 square yards, and the Agricultural Annex, with a large field near by for testing apparatus. One of the attractive points will be a model dwelling house equipped with all that can be devised in the way of domestic appliances.

The leading officials of the Exposition committee are: H. Dubs, president of the General Traction Company, of Marseilles; M. G. Cordier, president of the Energie Electrique Companie, of Paris, and of the Syndical Chamber of Hydraulic Power; M. G. Noblemaire, president of the Paris-Lyons-Mediterranean Railroads, including the general secretaries of the Exposition, R. Pinot, secretary of the Metallurgical and Mining Union; M. Desanges, president of the Water and Gas Company of Paris, and M. P. Certonciny, Honorary General Secretary of Colonies.

As to the recompenses which will be awarded by the jury these will consist of diplomas signed by the president of the Marseilles Commission, and by the General Commission of the show, and will represent five classes: Grand prize, gold medal, silver and bronze medals, honorable mention.

LETTERS TO THE EDITOR.

Grounded Neutral.

To the Editor of the Electrical Review:

In any electrical transmission or generating system having one ground the grounded point is the neutral of the system.

The expression "grounded neutral," as commonly used, is, therefore, a misnomer. What should be said is that the "grounding of the medial point" establishes such point, during normal operation, at neutral voltage.

The "grounding of the medial point" is the only means approximately to balance electrostatically the two sides of any circuit in which the transmission is either fluctuating or alternating.

It may or may not be interesting to know that the research work necessary for me to perfect this conclusion was carried out from 1882 to the commencement of this century, when I applied for the patents subsequently granted to me.

J. Stanley Richmond.

Toronto, January 21, 1908.

Effect of a Vacuum on Selenium.

To the Editor of the Electrical Review:

In an editorial entitled "How Does Light Affect Selenium?" in the Electrical Review of January 18, mention is made of Mr. G. M. Minchin's experiments upon the effect of a vacuum on the selenium cell.

The writer, in the course of an investigation of radiophony, conducted in 1903, made a large number of selenium cells, which were finally mounted in exhausted bulbs. He found, contrary to Mr. Minchin, that the vacuum slightly increased the resistance of the cell, and at the same time eliminated the "photo-electric" effect.

The cells were constructed of pipestone cylinders and cones, cut with a fine double thread, and wound with brass or copper wire. On the wire-wound surface melted selenium was spread in a very thin layer. These cells were repeatedly annealed, usually at about 217 degrees centigrade, and the "light" and "dark" resistances repeatedly measured. When a satisfactory resistance and response was reached, the cell was sealed in a small glass bulb, exhausted to a "lamp" vacuum.

In all cases, the effect of such mounting on the cell resistance was an increase, usually of the order of fifty per cent. Both the "light" and "dark" resistances were raised, but the ratio between these remained the same.

Mr. Hammer's observation regarding the "photo-electric" action, mentioned in the above editorial, is corroborated by the writer's experience. Most of the cells were kept in a desiccator, previous to mounting in the vacuum bulbs, and even under very intense illumination few showed "photo-electric" currents of more than a few hundredths of a micro-ampere. After a few hours in the exhausted bulb no "photo-electric" current could be detected, using a galvanometer of 2×10^{-9} ampere sensitivity. Owing to the high thermoelectric power of selenium, thermoelectric currents are often mistaken for "photo-electric" currents, as with strong illumination it is difficult to avoid unequal heating of the cell.

Greenleaf W. Pickard.

Amesbury, Mass., January 20, 1908.

Honors from France.

The American Museum of Safety Devices, of which Dr. Josiah Strong is president and Dr. William H. Tolman, director, gave a subscription dinner at the Aldine Association, this city, Wednesday evening, January 15, in recognition of the honor of the decoration bestowed by the French Republic on the following members of the museum's board: Charles Kirchoff, T. Commerford Martin and Percy Stickney Grant. Judge Elbert H. Gary presided, and addresses were delivered by Bishop Potter, Frank J. Sprague, Dr. Strong, Dr. Tolman and others. The recipients of the well-merited decorations responded in graceful terms. The occasion was a very pleasant one, and about 150 were in attendance.

ELECTRICAL ENGINEERING EDUCATION.[1]

BY CHARLES P. STEINMETZ.

When in the following I dwell more on those features of our electrical engineering education which appear to me unsatisfactory, it is not that I overlook the many good points, but rather that a criticism of the few defects appears to me more important, for the purpose of urging their elimination.

In general, the conditions for a good electrical engineering education in the United States are far more favorable than anywhere else; for an electrical engineering industry developed to a higher degree and to a greater magnitude than in any other country offers a very large field of application to the graduate engineer, thus supplying an incentive to enter this profession. Unlike other countries, where some opposition to the college-trained man, as unpractical, still lingers, the electrical industries here prefer, and in many instances demand, a technical college training for their engineering staffs. There is a tendency now to demand this training even for administrative and commercial positions. This leads to a close cooperation between the electrical industry and the engineering college. The leaders of the industry take a close and active interest in technical educational work, while teachers of engineering consider it as their foremost duty closely to follow and keep informed of the advances of the electrical industries, sometimes even are actively engaged in industrial work; and as early as possible the students are introduced to the industry, by visits to factories, inspection trips, etc., which become more and more an important part of the college education. This is as it should be, and probably constitutes the strongest features of American engineering education.

While many, especially smaller colleges, are not financially strong, in general the means available to the American college of engineering are far superior to those abroad, and especially in erecting engineering buildings, laboratories, etc., much has been done.

The great defect of the engineering college is the insufficient remuneration of the teaching staff: the salaries paid are far below those which the same class of men command in industrial work, and as a result the college can not compete with the industry for its men, and most of the very best men are out of reach for the colleges. The teaching forces of the colleges therefore consist of: 1. A few of the very best men, who are specially interested in educational work to such an extent that they are willing to sacrifice financial returns for it. These men have made the engineering college what it is; but even many of these men are ultimately forced by considerations of family, etc., to leave college work and enter industrial employment. 2. Many younger men interested in teaching, enter college work to give it a trial. Some of these remain, but many return to industrial work, when they are forced to realize the small prospect of financial return offered by the college. 3. First-class men who devote a part of their time to the college and a part to industrial work, usually consulting engineering. This arrangement is probably the best for the college, handicapped as it is by the policy of salaries which may have appeared sufficient in branches in which no industry competes, but which are suicidal in the engineering department. Still it would be far preferable if the colleges could get the benefit of the whole time and the undivided interest of these men.

It appears to me, therefore, that a vast improvement could be made in electrical engineering education if a large part of the sums which now are devoted to marble engineering buildings and fancy laboratory equipments could be devoted to offer such salaries as to make available to the colleges the undivided time and interest of the best men in the field. The name of the donor may just as well be perpetuated by the professorship which he endows, as by the pile of marble which he erects for the college. After all, engineering buildings and college laboratories are of very secondary importance compared with the qualifications of the teacher and his assistants.

To the subjects taught and the methods of teaching very grave objections may be made. The glaring fault of the college curriculum is that quantity and not quality seems to be the object sought: the amount of instruction crowded into a four years' course is far beyond that which even the better kind of student can possibly digest. Memorizing details largely takes the place of understanding principles, with the result that a year after graduation much of the matter which had been taught has passed out of the memory of the student, and even examinations given to the senior class on subjects taught during the freshman and sophomore years, reveal conditions which are startling and rather condemnatory to the present methods of teaching.

It stands to reason that with the limited time at his disposal, it is inadvisable for a student to waste time on anything which he forgets in a year or two; only that which it is necessary to know should be taught, and then it should be taught so that at least the better student understands it so thoroughly as never to forget it. That is to say, far better results would be obtained if half or more of the mass of details which the college now attempts to teach, were dropped; if there were taught only the most important subjects—the fundamental principles and their applications—in short, all that is vitally necessary to an intelligent understanding of engineering, but this taught thoroughly, so as not to be forgotten. This, however, requires a far higher grade of teachers than are needed for the mere memorizing of text-book matters, reciting them, at the end of the term passing an examination on the subject and then dropping it. The salaries offered by the colleges are not such as to attract such men. When the student enters college he is not receptive to an intelligent understanding, for after a four years' dose in the high school of the same vicious method of memorizing a large mass of half, and even less, understood matters, the student finds it far easier to memorize the contents of his text-books than to use his intelligence to understand the subject-matter. After graduation, years of practice do for the better class of students what the college should have done—teach them to understand things. It is, however, significant that even now young graduates of foreign universities, in spite of the inferior facilites afforded abroad, do some of the most important electrical development work of this country. Men who never had a college education rise ahead of college graduates. This would be impossible if our college training gave what it should, an intelligent understanding of electrical engineering subjects.

The cause of the fault is perhaps the same that leads to the erection of engineering buildings and laboratories while underpaying the teaching staff: the competition among the colleges. To the father who looks up a college for his boy, marble engineering buildings and fancy laboratories are impressive, and so is an extensive curriculum; the result is a rapid increase in the number of students; but it is not to the benefit of the student, since the faster a subject is learned the faster also it is forgotten, and to become and

[1] A paper read before the American Institute of Electrical Engineers, New York, January 24.

remain thoroughly familiar with a subject, it is necessary to keep up the study of it for some years. While it is a good feature to insure application of the student by term examinations, etc., this becomes harmful if it leads to dropping the subject at the end of the term. The least that can be expected from the college is that at the time of graduation the student still knows all that he has been taught during his college years. To accomplish this it is necessary to keep up the study of every subject to the end of the college course. This is not the case at present.

The different colleges vary between the school teaching the trade of electrician, and that attempting to give an intelligent electrical engineering education. At the one extreme is the college which dropped from its curriculum everything not required in electrical engineering. Such a school covers a large ground in electrical engineering, may even consider shortening the course to three years. The graduate of such a course is a full-fledged electrical engineer, capable to ply his trade, just as a plumber or bricklayer when graduating from his apprentice years, and just as helpless and useless when any occasion arises requiring general knowledge to enable him to understand matters beyond his trade. The unavoidable result of such training is, that when with the development of the industry subjects become of importance which were not considered as pertaining to the trade of electrical engineering during his college years, his usefulness is impaired, younger men rise above him, and he can not hope to rise beyond a subordinate position. Fortunately, the better technical colleges realize that the first requirement of an electrical engineer is a thorough general education, and begin to realize that for this purpose it is not sufficient to require general subjects for college entrance and relegate their study to the high school: for even if the average high school were what it should be and not what it actually is, much of the general knowledge required by an educated man can not be taught in the high school, since during the high-school years the intelligence of the boy is not sufficiently ripened for its grasp, and a review in the college is necessary.

However, even if an attempt is made to teach or to review general subjects, the work is not carried sufficiently far. Mechanical engineering, physics, chemistry, and some civil engineering subjects are recognized as legitimate subjects of teaching in the electrical engineering course in many colleges, together with literature, some history, etc.; but physiography, physical geography, meteorology, mineralogy, astronomy, etc., are also of importance in a general engineering education. The failure to recognize this may sometimes be a severe handicap to the electrical engineer, and that in the not very far future, judging from the present trend of development. In this direction the student, as well as his parents, are frequently antagonistic, and can not see why subjects should be studied which, to their limited horizon, appear unnecessary.

The instruction given in those branches of science, a knowledge of which is required by the electrical engineer, but to which only a limited time can be devoted, as chemistry, civil engineering, etc., frequently is very unsatisfactory, being unsuited to the requirements of the electrical engineer, and, as result, of very little if any value to him. A general knowledge of these branches is required, so as to familiarize the electrical engineer with the general problems, methods, and purposes of the science; to enable him to understand subjects dealing with these sciences. The ability actively to practice the science is not required. To illustrate in the case of chemistry: the electrical engineer should have a knowledge of the laws of chemistry, a familiarity with the elements and their compounds, and a general knowledge of the methods of analysis and synthesis. Such a course must, therefore, necessarily be largely descriptive, and the experimental work largely illustrative. The same course is frequently given to the electrical engineer as to the first few terms of the chemistry student: general inorganic chemistry of the most important elements, and qualitative analysis. While a first-class beginning of a course of chemistry, such a course leaves the engineer with a knowledge altogether too fragmentary to be of benefit to him, and the time spent in mastering the mechanism and the details of qualitative analysis is largely wasted, since the electrical engineer will probably never be called upon to make an analysis. If he attempted to do so he would probably fail. The beginning of a chemist's training is not suited to the chemical training of the electrical engineer, and the same applies to all other sciences to which a limited time is devoted in the electrical engineering curriculum. To give a general view and working knowledge to the electrical engineer of such an allied branch of science, theoretical discussions, especially mathematical, are usually very little needed and therefore undesirable. A characteristic case of spoiling a science to the student by mathematics is that of astronomy. Astronomy is one of the most interesting and fascinating of subjects. But where taught as a part of the general educational programme, it frequently is all mathematics, and so hopelessly dry and repellent. It should be given descriptively, for in a short course on astronomy it is just as ridiculous to delve deeply into mathematics as it would be to start the teaching of geography with a course in spherical trigonometry. I believe that in the teaching of allied sciences our colleges and schools are still greatly inferior to those abroad; the result is very marked in the product of the colleges, in the inferiority of the general education possessed by our graduates.

It goes without saying that in all teaching the strongest endeavor should be made to correlate the different subjects, to show the students the close relations which exist between all the branches of science, no matter how different they appear at first sight; and to interest him by bringing home to him the practical importance of what otherwise would appear dry theory. For instance, by using, in the teaching of mathematics, problems taken from engineering; to have him handle and operate machines before proceeding to their theoretical investigation; then to derive the constants of the theoretical investigation from experimental tests of the apparatus; and from these predetermine the performance of the apparatus under different normal and abnormal conditions and experimentally verify it.

In conclusion, the main defects in the present electrical engineering training in some of our colleges appear to me as follows:

1. The insufficient remuneration of the teachers, which makes most of the best men unavailable for educational purposes and is, therefore, largely responsible for the other defects.

2. The competition between colleges, which leads to a curriculum marked more by the quantity of the subjects taught than by the thoroughness of the teaching. The graduates are sent out with a mass of half-understood and undigested subjects, quickly forgotten, and deficient in understanding of the fundamental principles and in the ability to think.

3. The tendency of some colleges to teach the trade of electrical engineering rather than educate intelligent and resourceful electrical engineers.

4. The unsatisfactory state of the teaching of allied sciences, which gives instead of general view and understanding of the science, a fragmentary knowledge of some details.

THE BEST ENGINEERING EDUCATION.[1]

BY CHARLES F. SCOTT.

The recent rapid development of the electrical industry owes its vitality to the engineering school. Its graduates have done the designing, constructing, operating and directing which have made possible the rapid progress and wide extension in the use of electricity. The ideals, the equipment and the methods in engineering education, as well as the number and size of the schools, show a remarkable rate of progress. In fact, the advance in the electrical industry, in engineering education and in the American Institute of Electrical Engineers, closely correspond when measured numerically. There has been a close interrelation between them.

The future prosperity of the industry and of the Institute depends upon the efficiency of engineering education to an extent which one realizes more fully the closer he studies the subject. It well merits our best thought.

A review of the papers which have been presented to the Institute on engineering education shows that among our modern professors there are those who are active and alert and up to date. There is a marked agreement between the teaching profession and the engineering profession, both in an appreciation of the importance of the subject and in the general purposes which the engineering school should aim to accomplish. As engineers, it is quite unnecessary to argue that our schools should be more efficient and that their graduates should be better equipped for the work they are to do, as the professors are urging us to tell them how to accomplish these very objects.

Before discussing how to do something it would be well to decide what it is we desire to do. What do those who use engineering graduates want them to be able to do? Ideas have varied. Some expect trained artisans; others, trained engineers who are ready at once to do any kind of engineering work. Some expect technical specialists; while others call for men of ability who have a general preparedness for doing any kind of work. Some are disappointed if graduates are not immediately productive; while others provide courses of practical training. As all boys are not alike, and as their future employers have different ideas, and as their jobs will not be the same, it reasonably follows that there is room for more than one kind of training in college. The problem is not wholly abstract; it is vitally concrete. Its solution is not a rigid and narrow one, but it involves general policies. The details of method are to be determined by varying conditions and are to be adapted to the varying personal qualities of the young men.

In general, instruction in engineering schools is of three varieties:

a. Practical or industrial.

b. Scientific.

c. Cultural.

Practical or industrial studies are intended either as illustrations of scientific principles or as a direct preparation for business or professional life.

Scientific studies are the foundation for the applications and make the latter possible.

Cultural studies broaden the student's mental horizon, offset the narrowing effects of technical studies and prepare for activities which are not purely technical.

The best engineering education is that which fits the individual student for his largest development and usefulness in the long run, not necessarily immediately after graduation. The problem, therefore, is to divide the four years spent in school among the three classes of studies in such proportion as will bring about the best results.

The problem is largely one of elimination, as, if all the studies were included which have been suggested as being essential or desirable in the training of an engineering student, the college period of four years would have to be increased to possibly twenty or thirty years.

Among the questions which arise in the discussion are the following:

1. The desirable characteristics of the acceptable graduate with respect to:

a. Practical familiarity with electrical apparatus which will enable him to be immediately useful, *versus* a less practical and more general training, which is to be supplemented by an apprenticeship course or its equivalent.

b. Specialized technical training and technical knowledge, *versus* a broader education aimed to develop intellectual power rather than the acquisition of technical knowledge.

2. The arrangement of subjects and courses which will best produce the desired results. The following questions arise:

a. The relative attention to be given to the practical or industrial, the scientific and the cultural.

b. The relative proportion between subjects which are valuable for imparting technical knowledge and those affording training in scientific and logical methods.

c. The relation between school instruction and practical work, whether one should precede the other, and if so which one should come first, or whether they should alternate once a day, once a year or at some other rate.

d. The importance of current engineering practice; of lectures by practicing engineers; of discussion of current topics in local meetings of the Institute.

e. The degree of desirable differentiation in courses or methods on account of differences in the characteristics of individual students or in the fields of work they expect to enter.

f. The sequence of subjects—whether the theoretical groundwork should be laid during the first few years and the practical subjects reserved until the latter part of the course, or whether an intermingling of the two in accordance with the concentric method outlined by Professor Karapetoff is to be preferred.

I venture the prediction that the solution which will find most general acceptance will be that which gives to each student the training which fits him for his largest individual development; that for those who are qualified to take an active rather than a passive attitude toward their work the broader education, which emphasizes training rather than knowledge, will be chosen; that a fairly intimate intermingling of college work with practical work will be found to conduce to the efficiency of each, and that the field in which the greatest difference of opinion will be present will be with regard to the proposed concentric method. This system clashes with time-honored educational ideals, but it presents arguments which are so rational that the existing method must assume the defensive.

[1] From a paper read before the American Institute of Electrical Engineers, New York, January 24, 1908.

Electrification of Steam Railways.

Edward P. Burch, electric railway engineer, is giving a course of lectures to the senior electrical engineering students at the University of Minnesota on "Electric Traction for Heavy Railway Service." These lectures supplement the regular course in electric railways by Professor Springer, and include the following subjects: "Introduction," "Advantages of Electric Traction," "Characteristics of Steam Locomotives," "Characteristics of Electric Locomotives," "Problems of Electrification," "Load-Factor, Cost of Steam and Water Power," "Power Plants and Transmission Lines," "Plans of Complete Electrification," "Data Sheets."

Plan and Agreement for the Readjustment of Debt of the Westinghouse Electric and Manufacturing Company.

A committee representing the holders of a large amount of the debt of the Westinghouse Electric and Manufacturing Company, acting as a readjustment committee, has worked out a plan for the readjustment of the debt, and the committee believes that if the conduct of the business can promptly be restored to the stockholders, under the direction of a strong board of directors, the company will continue to make substantial earnings.

The business of the company is so complex and its indebtedness so widely scattered that the only effective method of providing for an early termination of the receivership and the protection of the creditors is by the immediate concentration of the indebtedness under the control of a committee with ample power to carry through a plan of readjustment with a minimum of delay, and in the meantime support the receivers in their efforts and continue the business and maintain the good will of the company.

The issue of $35,000,000 first-mortgage and collateral-trust five-per-cent twenty-five-year gold bonds is proposed. This issue is to be secured by a first mortgage upon the principal manufacturing plants of the company and by the pledge of the greater part of the company's unpledged holdings of the stocks and bonds of subsidiary and other companies. The committee shall have the power, in its discretion, to determine the provisions of the deed of trust securing these bonds. The bonds are to be in denominations of $1,000, and are to bear interest from January 1, 1908, payable semi-annually. Of this issue of bonds an amount not exceeding $20,469,000 face value is to be convertible, at the option of the holder or registered owner, at any time after January 1, 1910, and up to thirty days prior to any date of redemption which may be named in any call for redemption, into stock of the company, upon such terms and conditions as shall be provided in the deed of trust. In case preferred stock be issued for the new capital provided for, then the stock to be issued upon such conversion shall be "assenting stock," if the present corporation be retained; but if a new corporation be organized and preferred stock of such new corporation be issued for said new capital, then the stock to be issued upon such conversion shall be common stock, and, in either case, stock shall be issued upon such conversion at the rate of $1,000 par value of stock for every $1,000 bond. If, however, the stock to be issued for such new capital shall be "assenting stock" or common stock, as the case may be, then the stock to be issued upon such conversion shall be of the same character and shall be issued at the rate of 125 per cent of par. All bonds are to be subject to redemption, at the option of the company, at 105 and interest, at such times and on such terms as shall be provided in the deed of trust. The deed of trust shall provide for sinking-fund payments of $1,100,000 per year, beginning with the year 1911, but only out of the net earnings of the company after deducting all interest charges beginning with the earnings of the fiscal year ending April 1, 1911. The sinking fund shall be cumulative, so that any deficiency therein shall be a charge upon and payable out of the net earnings of the subsequent years. Such sinking-fund payments shall be divided between the convertible and non-convertible bonds in the proportion of $500,000 for the convertible bonds and $600,000 for the non-convertible bonds.

The present debt, exclusive of interest, based upon statements furnished by Messrs. Haskins & Sells, who have been auditors of the company since 1902, is as follows:

UNSECURED DEBT:		
Convertible sinking fund five per cent gold bonds, due January 1, 1931		$18,500,000
Five per cent gold debenture certificates, due July 1, 1913		1,969,000
Bills payable	$9,209,766.21	
Accounts payable, about	3,952,843.13	
Indebtedness of subsidiary companies, subscriptions to stocks or bonds of subsidiary companies and endorsements of notes of subsidiary companies and other obligations, for which provision should be made, about	1,368,390.66	
Total floating debt, about		14,531,000
Total unsecured debt to be provided for, about		$35,000,000
DEBT SECURED BY COLLATERAL:		
Three-year six per cent collateral notes, due August 1, 1910		$6,000,000
Ten-year five per cent collateral notes (French loan) due October 1, 1917, about		2,750,000
Total secured debt, about		$8,750,000

The proposed distribution of first-mortgage and collateral-trust bonds is arranged as follows:

To be issued in exchange for existing convertible bonds at par (these bonds to be convertible into stock)	$18,500,000
To be issued in exchange for existing debenture certificates at par (depositors of certificates to have the right of election as between convertible and non-convertible bonds)	1,969,000
To be issued for existing floating debt at par, say	14,531,000
Total	$35,000,000

Unless otherwise specified by the committee, the consummation of the plan is to be conditioned upon subscriptions for the payment of $7,000,000 new capital into the treasury of the company for stock. Such subscriptions shall be payable in such instalments as the committee may approve. Any creditor may accept for part or all of his claim stock of the company at the same price at which it shall be issued for said new capital. Subscriptions to stock so made by creditors may, in such an aggregate amount as shall be approved by the committee, be deemed a part of the $7,000,000 subscriptions hereinbefore provided for, and in such case a corresponding amount of bonds issued under the deed of trust shall be available for use in the discretion of the board of directors of the company.

The plan is to be carried out by a committee consisting of James N. Jarvie, A. G. Becker, Richard Delafield, Charles A. Moore, Neal Rantoul, F. H. Skelding and Albert H. Wiggin.

Electrical Supplies for the Navy Department.

The Bureau of Supplies and Accounts will open bids in Washington, D. C., on February 11, for the following electrical supplies: 4,500 feet lead-covered cable and miscellaneous electric spare parts for thirty-foot electric gig, for delivery at Washington, D. C.; miscellaneous electrical supplies, for delivery at New York city, and 1,600 pounds insulating cotton tape, for delivery at Boston, Mass.

Bids will be opened on February 18 for miscellaneous electrical supplies for delivery at Annapolis, Md., and 175 pounds of insulating tape for delivery at New York city.

Bids will be opened on February 25 for the following electrical supplies: one portable air-compressing outfit, 100 Edison-Leland type Q battery renewals, 536 miscellaneous dry cells, six sparking dynamos, miscellaneous electrical supplies, 500 Shoemaker Leyden jars, two power-factor round switchboard type meters, 403 troy ounces of platinum, five automatic starting panels with accessory appliances, 100 condenser plates, thirty-six graphite resistance rods, twelve telephone receivers, twenty-two pieces polished slate, six watt-meters, voltmeters, etc., for delivery at Mare Island, Cal.; 37,000 feet steel enameled conduit, 3,000 feet interior cable, miscellaneous conduit fittings, 400 pounds rubber insulating tape and 2,100 pounds magnet wire, for delivery at Puget Sound, Wash.

New York Electrical Society.

The next meeting of the New York Electrical Society will be held on board the Cunard steamship Lusitania, New York city, on Wednesday evening, February 5, at 8 P. M.

The Largest Electric Supply System in Vermont.

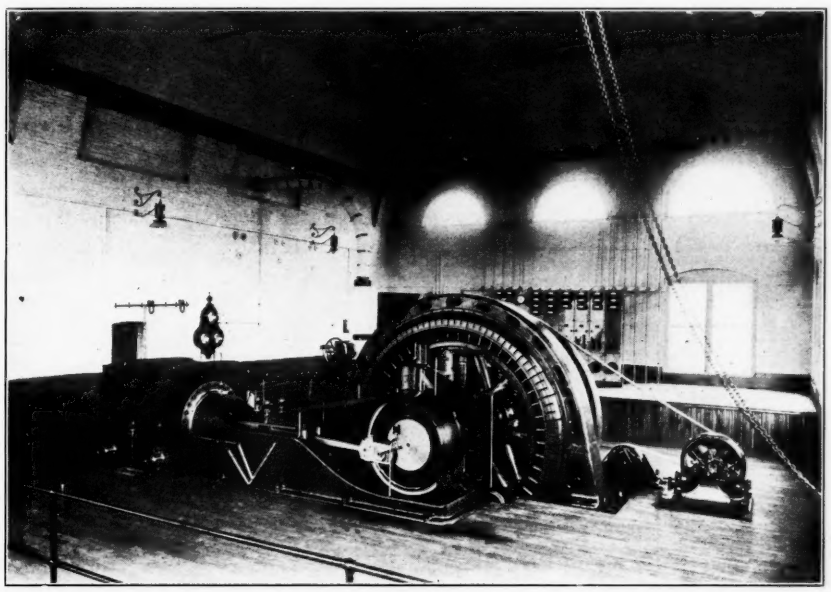
BOLTON FALLS marks one end and Williamstown the other of the longest transmission and the largest electric supply system in Vermont. Included by this system are the largest hydroelectric station, the largest steam-driven electric plant, the greatest connected load and the greatest stationary motor load in the state. On its way, this electric system passes through and serves Waterbury, Montpelier, Barre, South and East Barre, Graniteville, the quarries and Williamstown. The water-power plant is at Bolton Falls, the steam-generating station at Montpelier, and the substations are at Waterbury, Montpelier, Barre and Graniteville. The population served by the electric system is estimated at nearly 30,000. From Bolton Falls to Williamstown the distance along the transmission line is twenty-six miles by way of the steam-power station at Montpelier, and this station is ten miles from Williamstown and sixteen miles from Bolton Falls. Thus it is that along the Winooski Valley, between the highest of the Green Mountain peaks, there is located a greater electric supply system than any to be found in the larger cities of Vermont. This system is owned by the Consolidated Lighting Company of Montpelier. Along some twenty-three of the twenty-six-mile stretch of transmission line the voltage is 12,000, with three-phase, sixty-cycle current, from Bolton Falls to Graniteville. The entire length of line operated at this voltage is increased to twenty-five miles by the two-mile run to Barre from the point where the branch to Graniteville is connected. Current of 12,000 volts is supplied to the line by the electric generators at Bolton Falls and also by those in the steam-driven station at Montpelier, with the intervention of transformers at the latter point. In the substations at Waterbury, Barre and Graniteville, and in the combined generating and substation at Montpelier, the 12,000-volt, sixty-cycle, three-phase current is transformed to 2,300 volts for local distribution. At Waterbury the equipment includes two forty-kilowatt oil-cooled transformers of General Electric make. In the station at Montpelier there are two variable ratio transformers of 100-kilowatt capacity each for general electric supply, and two other transformers of like capacity connected to a motor generator for the street railway. All four of these transformers are cooled with air blast. The motor-generator set consists of a 150-kilowatt, sixty-cycle, three-phase, 2,300-volt motor, direct connected to a 550-volt, direct-current generator of like capacity. Besides this motor generator, the electric railway has a 180-kilowatt, two-phase rotary converter and a storage battery at its car-barn nearby, but this converter is not intended to operate when the motor generator is in use. Four transformers are located in the substation at Barre, two being of the General Electric and two of the Westinghouse make, and all are oil-cooled. These transformers are connected in pairs to reduce the 12,000-volt, sixty-cycle, three-phase current to 2,300 volts, two-phase, for general distribution to lamps and stationary motors about the city. In the substation at Graniteville, which is located in the group of hills some four miles from Barre city, where extensive granite quarries are operated, the transformer equipment consists of six 100-kilowatt units working from 12,000 to 2,300 volts, all of the air-blast type and made by the General Electric Company. From this last-named substation the 2,300-volt current is distributed among the quarries, mainly for power purposes, and also goes to East Barre and Williamstown.

STEAM PLANT POWER-HOUSE, CONSOLIDATED LIGHTING COMPANY, MONTPELIER, VERMONT.

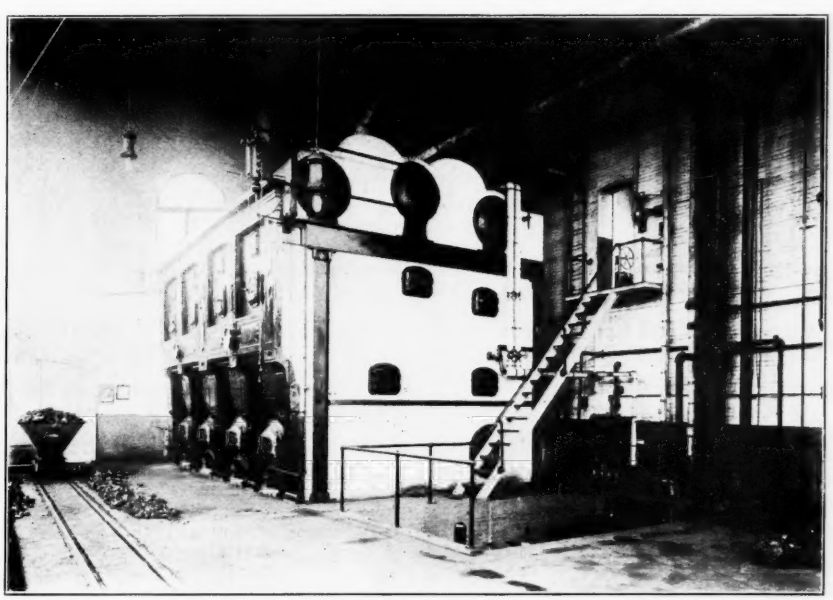
By the above figures it may be seen that the capacity of transformers at Waterbury is eighty kilowatts; at Montpelier, 400 kilowatts, including the railway equipment; at Barre, 800 kilowatts, and at Graniteville, 600 kilowatts, making a total capacty of 1,880 kilowatts in trans-

formers that operate between 12,000 and 2,300 volts.

Bolton Falls marks the point where the Winooski River breaks through the main chain of the Green Mountains, and drops its waters fifty feet toward the level of Lake Champlain. Above these falls, back in the heart of Vermont, between its numerous minor mountain chains, from the north, the east and the south, Little River, North Branch, Stevens Branch, Dog River, Mad River and many lesser streams discharge into the Winooski, giving it a drainage area of more than 800 square miles. Ten miles to the north of Bolton Falls is Mount Mansfield, whose summit rises to an elevation 4,829 feet above the sea, the highest in the state. Some four miles south of the same falls is Camel's Hump, which is only 4,088 feet high, but is quite as picturesque as its greater rival. Both of these mountains are elements in the great chain that divides Vermont from north to south, and the break in this chain is but little more than wide enough to let the Winooski River through at Bolton. About seven miles down-stream from this gap in the mountains is Richmond, and the Winooski has no large tributary on the way.



ELECTRIC PLANT OF THE CONSOLIDATED LIGHTING COMPANY, MONTPELIER, VERMONT.



BOILER PLANT, CONSOLIDATED LIGHTING COMPANY, MONTPELIER, VERMONT.

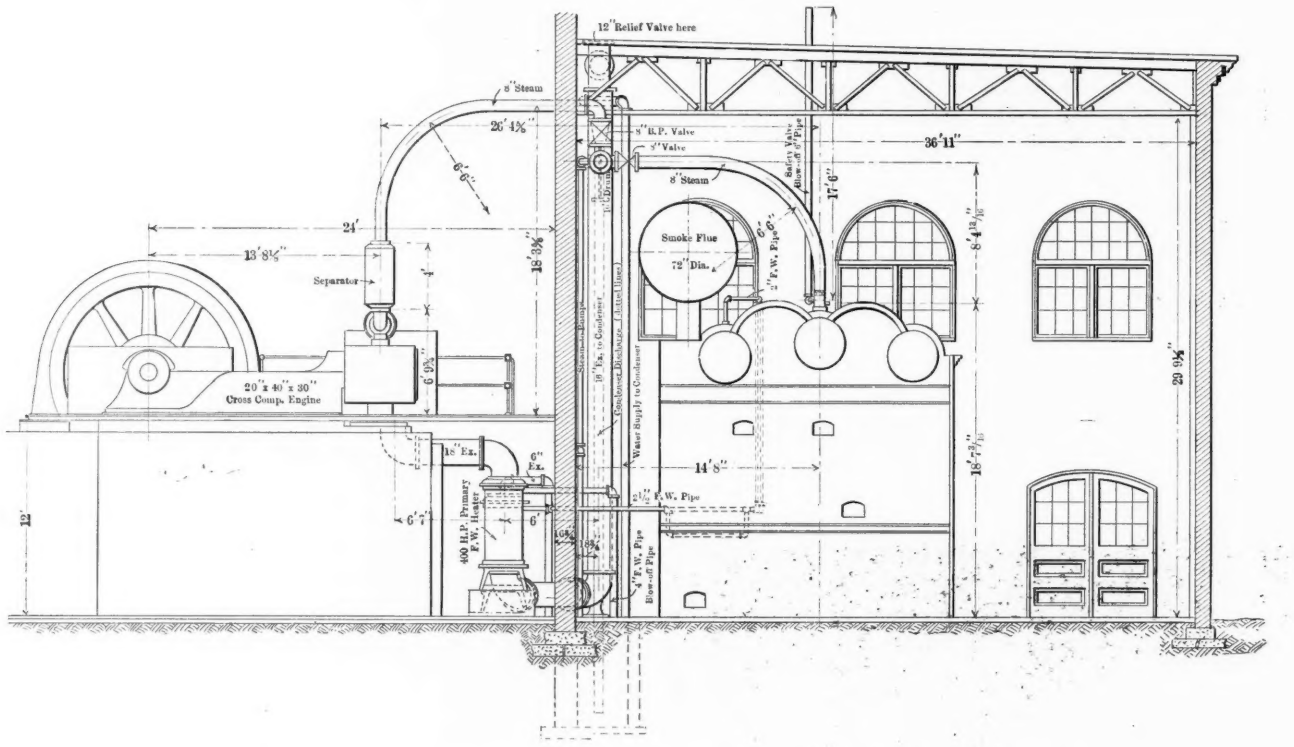
Records of the United States Geological Survey for the discharge of the Winooski River at Richmond, above which the drainage area is 885 square miles, show a maximum average discharge of 900 cubic feet per second on one day of July, 1904, and a minimum discharge in that same month of 152 cubic feet per second as the average of one day. During April of the year just named the discharge of the Winooski was a minimum of 1,850 cubic feet per second as an average on one day, and a maximum of 7,600 cubic feet per second as the average of another day. On one day in October the average rate of discharge reached 7,670 cubic feet per second. These figures for rates of discharge represent the extremes for eight months of 1904, and in January, February, March and December of that year the flow of the Winooski was not computed because the river was covered with ice. At Bolton Falls, where the entire water rights are owned by the Consolidated Lighting Company, the river flows through a narrow rock-bound channel, and a dam 191 feet long gives an operating head of fifty feet for the wheels in the electric station. For the purpose of forming a forebay wall there is an extension 103 feet long at one end of the overflow section of the dam, so that its entire length is 294 feet. Back of the dam the natural level of the river is raised for a mile upstream, thus giving a storage capacity of 1,000,000 cubic feet per foot of depth, as the width is about 200 feet at the surface. The dam and electric station at Bolton Falls date back to 1899, but various improvements have since been made. In location the station building sets close to the river bank and just below the outer end of the forebay wall. From this forebay wall two steel penstocks run to one of the sides of the electric station that is parallel with the river bank, and the water from these penstocks, after passing through the turbine wheels and underneath that side of the station opposite to the one where it entered, is discharged just below the overflow section of the dam. Each penstock carries water for a pair of twenty-seven-inch Hercules wheels that operate at 360 revolutions per minute under the water head of fifty feet. Direct connected to each of these pairs of wheels is a 450-kilowatt, 12,000-volt, sixty-cycle, three-phase alternator, made by the General Electric Company. To one of these generating sets a twenty-five-kilowatt, 125-volt exciting dynamo is belted. Another exciting dynamo, of twenty-kilowatt capacity at 125 volts, is direct connected to

a twelve-inch Hercules turbine that takes its water from one of the two large penstocks. The switchboard for the equipment just named is of blue Vermont marble, and contains two generator, two feeder and one synchronizer panels. On these panels are mounted indicating voltmeters and ammeters made by the General Electric Company. A Tirrill regulator is employed to control the voltage, and the 12,000-volt generators are connected to the transmission circuits through oil switches without the intervention of transformers. Before passing out of the station each conductor of the two transmission circuits is connected to a group of five 2,200-volt lightning arresters of the brass cylinder type, each of which has four air-gaps.

From Bolton Falls to the steam-driven electric station in Montpelier the distance by the transmission line, which follows closely the banks of the Winooski, is seventeen miles. Connection between the two stations is made along this line by means of two three-phase circuits carried by single six-pin cross-arms on cedar poles. The three wires of each circuit are carried in the same plane and on one side of each pole. Direct support for the wires is provided partly by glass and partly by porcelain insulators mounted on standard wooden pins. Each of the six line wires in the two circuits is of bare No. 4 B. & S. gauge copper.

Between wires of the same circuit the shortest distance is sixteen inches. After running into the steam-power station at Montpelier, for connection to the 12,000-volt generators and the transformers there, so that both the water and steam power plants can be operated in parallel, the two three-phase circuits of No. 4 B. & S. gauge bare copper wire follow up the banks of the Winooski River to the substation at Barre, an additional four miles. On the way, at a point about 1.5 miles from the steam power plant, two branch circuits leave the Barre line, and run to the Graniteville substation. These circuits, like the others, are made up of No. 4 copper wires.

Electric lighting began in Montpelier with a T. & H. arc dynamo driven by water motors, which drew their supply from the city mains, in 1886. This method of driving was soon abandoned in favor of turbine wheels operating under a head of about nine feet, in a wooden building known as the pioneer station. This building was located on the bank of the Winooski River, at Montpelier, and the water power was derived from a low fall in that stream. When the electric plant at Bolton Falls went into operation, in 1899, this pioneer station at Montpelier became of minor importance for generating purposes, and the construction of the steam-driven plant has since been completed, not far from the original building. In spite of the small size of the city in which it is located, for Montpelier had a population of only 6,266 in 1900, this new generating station there, which began to operate in October, 1903, but is just receiving its complete equipment, is believed to have a capacity greater than that of any other connected with an electric-supply system in Vermont. The station is situated between the highway and the Winooski River, with just room for the tracks of a steam railway between it and the river bank. In elevation the building is one story high, with basement beneath the engine-room floor.

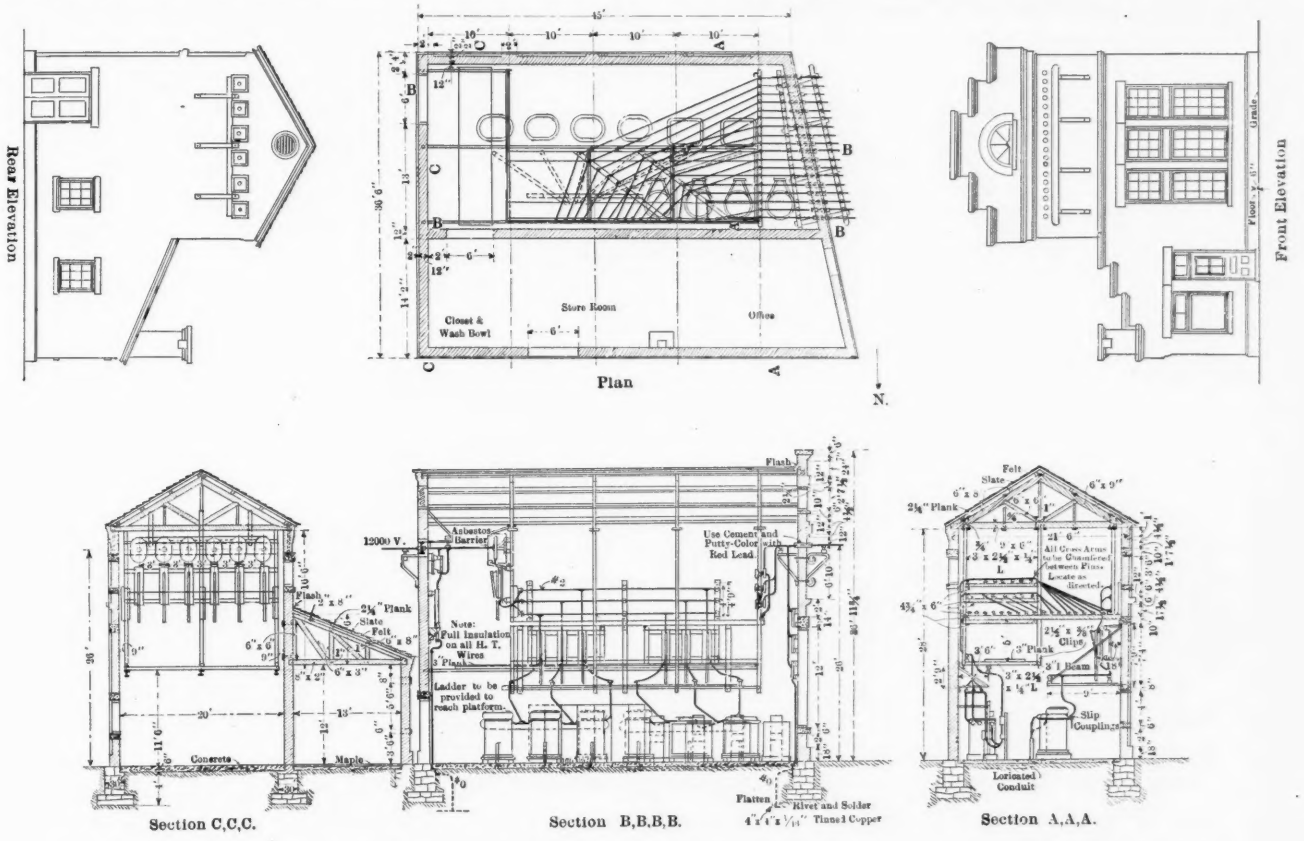


CROSS-SECTION THROUGH POWER-HOUSE, CONSOLIDATED LIGHTING COMPANY, MONTPELIER, VERMONT.

That part of the building which forms the boiler house does not rise as high as the remainder of the station, and its floor is nearly on a level with that of the basement beneath the engine room. Externally the station building is of pleasing architectural design. The walls are of solid brick without steel columns, the roof is of wood with a magnesia covering and supported on steel trusses, the engine-room floor is of wood, and the basement and boiler-room floors are concrete, and are seventeen feet above the normal water level in the Winooski River outside. At

one end of and outside the boiler room is an open storage yard for coal, adjoining the railway tracks. Near this same end of the boiler room is the round brick chimney, seventy-eight inches in diameter inside at the base, and 125 feet high, said to be the largest in Vermont. From the basement floor to that of the engine room the distance is twelve feet, and from the floor of the boiler room to the roof trusses over it is over twenty-nine feet. In floor plan the engine room is forty-one by sixty-three feet, and the boiler room sixty-three by thirty-nine feet. At that end of the engine room where the 12,000-volt transmission circuits enter, but outside of it, in a low brick addition, the transformers that operate between 12,000 and 23,000 volts are located.

Water for condensing purposes and to feed the boilers is pumped from the river through a pipe laid under the railway tracks. Two Stirling water-tube boilers installed in one battery and rated at 305 horse-power each are now in use, and a third unit of the same make and of 405 horse-power capacity is now being erected, all designed to operate at 160 pounds pressure. A smoke flue of seventy-two inches diameter connects the boilers with the chimney. In a pit four feet beneath the floor of the boiler room are one condenser pump and two duplex feed pumps. Steam from the two 305-horse-power boilers, at 140 pounds, is carried by an eight-inch pipe through a separator and to a twenty by forty by thirty cross-compound engine of the McIntosh & Seymour make, in the engine room. Exhaust steam from this engine goes to a primary feed-water heater and to a Bulkley condenser. Direct connected between the high and low pressure sides of this engine is a 500-kilowatt, 12,000-volt, sixty-cycle, three-phase generator of the revolving magnet type, made by the General Electric Company. The common speed of the generator and engine is 150 revolutions per minute. Besides this generating set, which has been in operation since the station was put into service, a 750-kilowatt, 12,000-volt, sixty-cycle, three-phase alternator, direct connected to a horizontal steam turbine, all of the Warren make, is now being installed. This gives the steam generating station a rated capacity of 1,250 kilowatts. Connected with this steam turbine are a Wheeler surface condenser, an air-pump and a centrifugal pump, in the basement. The turbine and its connected generator operate at 1,800 revolutions per minute. Belted to the cross-compound engine that drives the 500-kilowatt alternator there is a twenty-five-kilowatt, 125-volt exciting dynamo, made by the General Electric Company. With its tracks carried by piers along two of the brick walls of the engine room is a fifteen-ton hand-power Reading crane, which sweeps the entire engine-room floor. At that end of the engine room, where the 12,000-volt lines enter the brick wall, there is a platform, raised thirty inches above the general floor level, and on this platform the switchboard is located. This board is of blue Vermont marble, equipped with General Electric switches and indicating instruments, and includes two generator, two exciter, one synchronizing and six line panels, two for incoming and four for outgoing circuits. These circuits run down the interior face of the brick wall in the rear of the switchboard, and enter an apartment in the basement beneath the platform. From this apartment connections go to the switchboard, the generators, and the transformers before named, which latter are located in the small brick addition just outside of the wall near which the switchboard is located. In the apartment beneath the switchboard the oil switches for the three-phase, 12,000-volt circuits are located. At the opposite end of the engine room from



PLAN VIEW AND ELEVATION OF THE SUBSTATION, AT BARRE, OF THE CONSOLIDATED LIGHTING COMPANY, MONTPELIER, VERMONT.

that at which the switchboard stands, is the 150-kilowatt motor-generator for street railway operation, as previously described.

The entire system of the Consolidated Lighting Company, stretching from Bolton Falls to Williamstown, has a connected load of 196 arc and 207 series incandescent street lamps, sixty-two alternating-current commercial arc lamps, seventy-

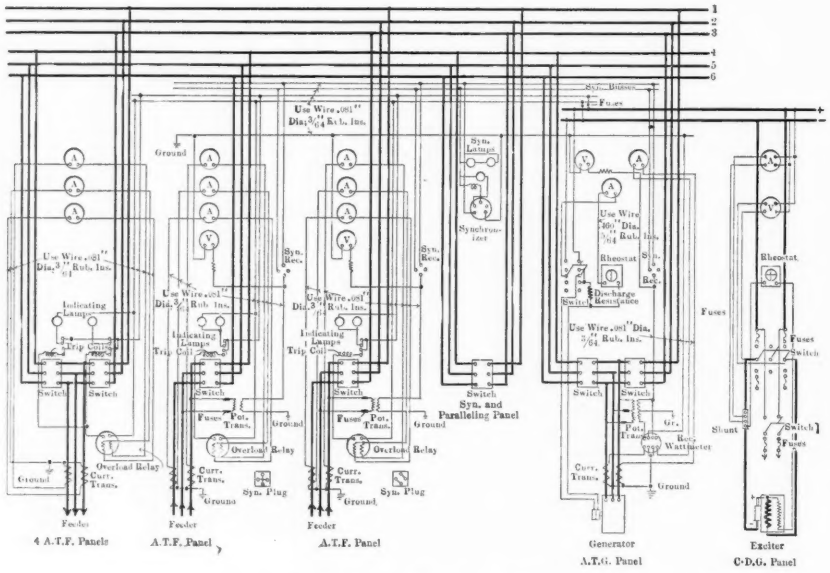


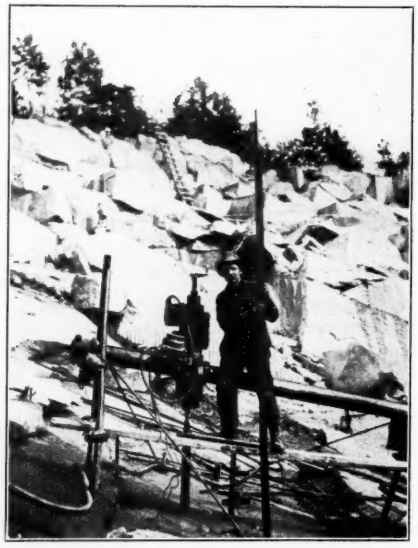
DIAGRAM OF CONNECTIONS, SWITCHBOARD WIRING, ELECTRIC PLANT OF CONSOLIDATED LIGHTING COMPANY, MONTPELIER, VERMONT.

five three-glower Nernst lamps, and 21,273 incandescent lamps of sixteen normal candle-power. Customers using lamps number 1,045, and customers using power forty-two. Constant-current transformers, located at the Montpelier station and the Barre substation, supply 7.5 ampere current for the series arc street lamps. In capacity of connected stationary motors the load of the Consolidated system is 1,180 horse-power, and much the greater part of this power load is utilized by the granite industry, at the quarries and the dressing sheds. All of these motors are of the alternating, induction type. Each granite shed, as a rule, uses only one motor and that of rather large size, and the load-factor is high, as may be seen from the following partial list:

Motor H. P.	Load Factor. Per Cent.	Motor H. P.	Load Factor. Per Cent.
50	62	50	92
30	53	40	72
30	74	30	53
30	62	40	99
40	77	20	65
50	99	10	46
20	72	10	34
5	78	50	92
40	104	15	31

A twenty-horse-power motor operating a machine shop shows a load-factor of thirty per cent, and a ten-horse-power motor in a creamery, a load-factor of twenty-one per cent, which may be compared with the figures in the above table for motors in stone sheds.

Though the cost of run of mine coal is $4.50 per ton at the steam-driven electric station in Montpelier, it appears to be $6.50 per ton at the quarries about Graniteville, which now use steam engines of



ELECTRICAL DRILL IN QUARRIES AT BARRE, VERMONT.

many hundreds of horse-power capacity. A large percentage of the power consumed in these quarries is used to drive air-compressors, and another important part is developed by the hoisting engines. Drilling in the quarries is now done almost exclusively with compressed air, at pressures of fifty to ninety pounds per square inch. The drill in regular use cuts a three-and-one-half-inch hole, and these holes often run down ten or twelve feet into the solid granite. To operate one of these three-and-one-half-inch drills with an air pressure of ninety pounds per square inch is said to require an expenditure of fifteen horse-power in driving the air-compressor. An electric drill was recently tried in one of the quarries for drilling the three-and-one-half-inch holes, and it is reported that this drill, while sinking such a hole as fast as could be done with an air-drill at ninety pounds pressure, consumed only two horse-power. In a certain quarry during a recent year the expense for fuel alone was $4,500, with three three-and-one-half-inch drills and several small plug drills operating at an air pressure of fifty-five pounds per square inch, besides three steam hoists and the usual amount of thawing out with steam. An electric motor was substituted for the steam engine driving the air-compressor at this quarry, the number of three-and-one-half-inch drills and of plug drills was doubled, and the air pressure was raised to ninety pounds per square inch. Under these conditions, at the rate charged for electric power at the quarry, the cost of energy to drive the motor for the air-compressor was found to be $450 per month, or at the rate of $5,400 per year. The estimated cost of operating the hoists, and heating about the quarry, was $100 per month, so that in this case the amount of work was more than doubled with the substitution of electric energy for steam power, while the combined cost of energy and fuel went to $6,600 per year, instead of $4,500 for fuel alone. It is to be noted in this case that not only was the number of drills doubled, but their operating air pressure was increased seventy to eighty per cent, thus giving each drill greater working capacity.

The Illuminating Engineering Society.

The next regular meeting of the New York section of the Illuminating Engineering Society will be held in the Engineering Societies Building, 33 West Thirty-ninth street, New York city, on Thursday evening, February 13. George Leland Hunter will present a paper entitled "Light and Color in Decoration."

American Institute of Electrical Engineers.

A special meeting of the American Institute of Electrical Engineers was held in the Engineering Societies Building Friday evening, January 24, to hear and discuss papers on the topic of engineering education. The meeting was called to order by President H. G. Stott, who called upon Charles F. Scott to present the first paper. This was entitled "The Best Engineering Education." An excerpt of this paper will be found on another page of this issue. At the conclusion of the paper Mr. Scott quoted from a paper which he had read at the recent meeting of the American Society for the Advancement of Science, in Chicago, in which he discussed the place of mathematics in the engineer's education and its value to the engineer. He took the stand that mathematics is a means and not an end, and should be taught with this in mind. It is a common opinion that higher mathematics are seldom or never used by engineers, but when this is the case it is generally because the engineer does not know how to use them. It should be the aim of the teacher to give the students facility in the use of mathematics.

The second paper of the evening was by Dr. Charles P. Steinmetz and was entitled "Electrical Engineering Education." This paper will be found in full on another page of this issue. After reading the paper Dr. Steinmetz said that he agreed thoroughly with Mr. Scott regarding the proper place for mathematics. This should be treated as a tool which is useful and valuable only so long as it is a tool, and becomes dangerous when the student is not able to follow the physical meaning of every mathematical step which he takes.

The discussion was opened by the reading of a communication from L. A. Osborne, manager of works of the Westinghouse Electric and Manufacturing Company, Pittsburg, by Professor H. H. Norris. Mr. Osborne summed up the impressions which he has gained from ten years' experience in selecting technical graduates for shop work. He believes that half of these men should not have studied a technical engineering course, as they are unsuited for it. For this reason engineering colleges should sift out their students more rigorously. Regarding the other half who are suitable for an engineering profession, the chief fault is that they are unable to grasp abstractions and to generalize. These opinions are based on the average impression. The engineer's training should give him a fine degree of discrimination, enabling him to know good from bad engineering. Engineers, to-day, are as a rule too self-centred, and are not men of the world, as their perspective is too narrow.

Professor H. E. Clifford, of the Massachusetts Institute of Technology, said there is danger in laying out a course which is too broad and not deep enough. He thought there was a danger in the tendency to standardize education. Education is an art and not an exact science, so that no rules of standardization can be applied. The personality of the teacher is an important factor and he should be encouraged to experiment in order to determine the best methods of producing the desired results. An aim of the course should be to teach men to think straight, to think from cause to effect, and this should be borne in mind both in the classroom and in the laboratory. Professor Clifford agreed that the students should be sifted out rigorously, and he went further and said that it might be advisable to segregate the men of exceptional and ordinary ability. The most important thing to do now is to reduce the number of subjects taught, but there is some fear on the part of the institution that should it do this, it would be thought to be narrowing its training.

Professor F. B. Crocker, of Columbia University, expressed strongly his disagreement with the concentric plan proposed by Professor V. Karapetoff at the convention of the Institute last summer, and which was so heartily endorsed in Mr. Scott's paper. Even should this system be thought ideal, as an abstract proposition, there are certain practical educational difficulties which are almost fatal. It is said that it is a system attractive to the students, and this effect would still further increase the number of students taking the technical courses and draw still more men not suited for the engineering profession. If fifty per cent of the graduates of a school should not have taken an engineering course, about seventy-five per cent of those who entered the institution should not have done so. Another difficulty is that since all of the exacting and difficult subjects are reserved for the fourth year, the classes of the previous years would be much overcrowded. Professor Crocker believes that in the first and second years there should be some subjects so severe and analytical as to eliminate those men who should not enter the fourth-year classes.

H. W. Buck said that the usual method of grounding a student in theory before giving him any laboratory work is wrong. The practical handling of apparatus should come before the theoretical discussion. This is a logical method, since it is the one followed in scientific advance; theories are based on known facts. A clear mental picture should be created in the mind of the student to furnish the foundation for the theory.

Professor W. S. Franklin, of Lehigh University, pointed out the difficulty which the instructors have of actually obtaining practical experience while they are teaching. More stress should be laid on elementary sciences, such as physics and chemistry. These courses should accentuate the fundamental things, and should be followed by elaborate courses in technology. The difficulty in the present study of some subjects is the overloading with details. It is important in all mathematical work to bear in mind the physical relations expressed in the formulæ. Professor Franklin agrees with Mr. Buck that the student should have some practical knowledge of the apparatus or phenomena before the theoretical study is taken up. A good deal of this the boy gets from his sports. Good use can be made by the teacher of the knowledge thus gained.

L. B. Stillwell said that since a man's work after leaving the technical school will be very narrow for some years, the course at the school should be as broad as possible. His experience leads him to believe that American engineers of to-day do not hold positions in the community commensurate with the part which the engineer plays in modern life; that the graduates of the technical schools, while having good mental ability, do not express themselves well, and that those who rise highest are the men of broader education. There is little difficulty in finding draftsmen and competent calculators, but "all-around men" are scarce. Higher executive positions are seldom held by engineers. Mr. Stillwell endorsed what Dr. Steinmetz said, that a great fault of the present courses is that they aim at quantity and not quality. One cause of this is undoubtedly the competition existing between the different colleges.

Professor Albert F. Ganz, Stevens Institute, did not see how the instructor could comply with the suggestions made by Dr. Steinmetz, to cut out a good deal of the work now given and yet carry all branches through all the years of the course. He believes that the school is the place where the theory must primarily be

taught, and it must be connected with practice by means of the laboratory. There are four objects to be accomplished by a technical education: first, training of the mind so as to make it an efficient machine; second, storing in the mind fundamental principles and facts; third, an acquaintance with sources of information, and, fourth, a general culture. He agreed with Dr. Steinmetz that it is better to analyze apparatus than to attempt actual design.

J. G. White agreed with the general opinion that the aim of the college should be to build up a theoretical foundation on the fundamental subjects which the engineer must know; among these, mathematics, physics and chemistry are the most important. He believes that all three of these can be carried through the college course. It would not be necessary to have special courses on each of these subjects, as work requiring knowledge of them could be given. Mr. White believes that the study of Spanish is important and that the knowledge of this language would be very valuable to the engineering graduate. He thinks that the ordinary instructor is too much inclined to lecture rather than use a text-book.

Professor W. E. S. Temple, of the University of Pennsylvania, said that there is no rule which can be applied to engineering education which will give the desired results irrespective of all local conditions. The education must consist in grounding the man in principles and general application while keeping away from special discussions. The man's ideal should be lifted high. He should be urged to hitch the wagon to a star. In furnishing such instruction it is not always desirable to stick strictly to the text-book; lectures are often desirable. The preliminary features may be given by means of books, but if the student is to be kept in touch with the developments of the science and art lectures can not be avoided. One of the most important features of the engineering student's education is that he should get the principles and general applications of certain of the important types of machines. One of the vital features in his training should be the requiring of promptness and accuracy. Individual instruction, so far as possible, is desirable, and it is often advisable to make the experimental work difficult intentionally so that the student will become accustomed to overcoming troubles. Professor Temple's objection to the concentric method is that it would tend to produce a somewhat finished artisan at the end of the first year, a little better artisan at the end of the second, and so on. It may be likened to a machine tool for doing ten or twelve different things, but none of them in the best way.

Louis A. Ferguson, of the Chicago Edison Company, said that the value of an engineering education is not so much in the actual knowledge acquired by the young man, but in the training which he has received. The accumulation of a mass of data is not the important thing, but the reasoning power which will serve the man in good stead. It is a mistake to try to jam the maximum amount of information into the student's mind in a year. Premium should be placed upon the development of reasoning power rather than memory. There is a tendency in some educational institutions to select the instructors from the graduates of the institution. This inbreeding promotes narrowness and does not give that stimulating effect which results from the bringing together of instructors taken from different schools. Instructors as a rule are not sufficiently encouraged by the college management to come into contact with the practical side of engineering. If industrial corporations find it profitable to send their engineers to other parts of the world to study conditions, why should not the same practice be beneficial for schools? The scope of the average courses in electrical engineering is too narrow. Such a course should include the fundamental principles of mechanical and civil engineering, chemistry and hydraulics, building construction, and general business law, as well as theoretical and applied electricity.

Dr. Samuel Sheldon, of the Polytechnic Institute of Brooklyn, pointed out that educational institutions are not always able to secure the best type of instructor because the compensation which they offer can not be compared with that which the same man would get in industrial work. To better these conditions it would be well if some co-ordinated action on the part of all the technical schools can be taken. To improve the present courses the thing to do is to curtail the subjects now presented, so as to leave room for cultural studies. To secure the advantages of the concentric method it should not be necessary to adopt the radical method proposed.

P. H. Thomas said that the factors of greatest importance underlying successful engineering are a thorough knowledge of the laws of nature and the properties of materials, familiarity with the mathematical and other logical processes, familiarity with the results of experience and acquaintance with the actual method of standards and practices in both. The actual period of an engineer's development is perhaps ten to fifteen years. Of this four years are given to school work, and during these four years the time should be devoted to the study of the fundamental principles and the logical process mentioned above. Acquaintance with actual methods can best be secured through practical experience. It is not for the practicing engineer to specify in detail the course of the technical school, but he may be permitted to suggest what such a course should include.

Professor W. L. Robb, of the Renssalaer Polytechnic Institute, said that one difficulty which had not yet been mentioned is the relative lack of preparation of the men who entered the technical schools. As a result the first two years in the school are not given to special subjects, but to general mental training. Under the present condition culture subjects have but a transient place in the technical school. They should be pushed back to the high schools and the entrance requirements of the technical schools should be raised. Professor Robb's present idea of the curriculum is that the first two years should be given up to the study of mathematics, chemistry, physics and English and an inflected language. The third year should be devoted to the fundamental principles of civil, mechanical and electrical engineering, and the fourth year to highly specialized subjects.

C. O. Mailloux said that the engineer's period of instruction is not limited to fifteen years, but extends throughout his whole working life. He agrees thoroughly with Mr. Stillwell that the course of instruction should be broadened and details eliminated. The present courses produce large numbers of mediocre men, but few able to do original work. The ideal method of giving instruction is to combine text-books with lectures. Too much emphasis has been laid upon the importance of bringing a student into physical contact with facts before teaching the theory. It is not so much the facts one discovers with his hands and eyes that are important as those discovered by the mind. While it is true that important theories have always resulted from observed facts, yet these theories themselves have led to important discoveries. A student can not have too much physics. The order of importance of subjects is physics, mechanics, chemistry and mathematics.

While much good may result in the co-operation of practicing engineers with teachers when giving instruction, there is also some danger. The practical man is only fit to teach when he has retained such contact with the theoretical side of his profession that he is still able to lead instead of mislead the student.

Professor D. C. Jackson, of the Massachusetts Institute of Technology, said that the student's education should be broadened, but it would be better that those courses unrelated to his technical studies should be taken up along with the latter rather than before. He was willing to admit the desirability of results which both Mr. Scott and Dr. Steinmetz have in mind, and he asked them to state specifically how they would secure them.

Philip Torchio, chief electrical engineer for the New York Edison Company, said that students may be divided into two classes—those following the technical course with the idea of carrying out original engineering work, and those which take it merely as a stepping stone to financial advancement. Theoretically the education of these two classes should be different. The first requires a greater equipment of mathematical and theoretical training than the latter, for whom the practical side is of much greater importance. He outlined briefly the curriculum of the Royal Polytechnic of Milan, Italy. The essential requisite for admission is a government certificate either of an eight-year preparatory course in lyceum, in which classical studies prevail, or a seven-year preparatory course in a technical institute where physical and mechanical studies and modern languages predominate. The average age of a freshman at admission is nineteen years. The course extends through five years, the first two being preparatory to all the engineering courses; the last three are sectionalized into civil, mechanical and electrical engineering classes. The first two years cover a thorough study of calculus and higher algebra, analytic, descriptive and projective geometry, general chemistry, mineralogy, physics, drawing, etc. In the next two years the mechanical and electrical engineers jointly follow, theoretically and experimentally, the studies of mathematical mechanism and applied mechanics, theory and design of steam, gas and water-power prime movers, the design and calculation of parts of machines, resistances of materials, hydraulics, organic and inorganic chemistry, surveying, descriptive study of industrial plants, technology of electricity, heating and ventilating, construction and the operation of railways. In the last year the electrical engineers in common with the mechanical engineers complete the situation in mechanics, hydraulics, mining, technologies, etc., and make two theses, consisting of comprehensive detail drawings of a prime mover and plans of an industrial plant, and follow separately the course of dynamo and transformer design and operation, industrial applications of electricity, theory of electrical measurements and laboratory work. These courses require forty-eight hours a week—eight hours a day, half of which is given for lectures and recitation, half for laboratory work and drafting.

President Stott emphasized several points. The discussion might be summed up by saying there is a lack of general education of the freshman who starts in college. This is caused by the hodge-podge and smattering he gets in primary schools—a little of this and that, and nothing of anything. The cure for this is to raise the standard of the entrance examinations. The discussion also seemed to agree that the engineering school should teach the fundamental principles and not engineering practice. When the student is graduated he is not an engineer, and for this reason Mr. Stott does not think that degrees should be granted until the man has been out of college for at least five years. This is the custom followed in Great Britain respecting the medical profession.

Mr. Scott, replying to the discussion, said that Professor Jackson's question could not be answered in a single sentence, but that solution which will find most general acceptance will be the one which gives each student the training which fits him as an individual for the largest individual development and not for getting the biggest job or the biggest salary. It should be recognized that there are two classes of men: those who are good for the ranks and those who will become leaders. It is rather remarkable that engineers are seldom found in the latter class. In introducing the subject he referred to the concentric method and not a particular concentric course. This method appeals to him as being logical and psychological.

Dr. Steinmetz said that Professor Jackson's question was answered in his paper. The thing to do was to drop out a sufficiently large part of the quantity which the college now attempts to teach so as to get the time to improve the quality of the rest by teaching it thoroughly; that is, going over the subject again and again, teaching it from different points of view. Only in this way can the student thoroughly understand the subject. He does not believe in text-books, although these are, of course, valuable where the instructor is deficient. He believes that the concentric method is thoroughly good, although he can see two difficulties in applying it. One is that after going over the subject the first time the student loses his interest and neglects the work, thinking he already knows enough about it. The other is that before it will be possible to modernize and improve the education of the boy it will be necessary to modernize and educate the college staff.

The meeting was then adjourned.

The Home Show in New York City.

At the Home Show to be held at the Grand Central Palace, New York city, May 2 to 9, 1908, a large exhibit of devices and appliances for use in the home will be made. The object of this show is to bring together and exhibit products of all the industries in any way connected with the making of a home. This includes building materials, heating and lighting devices, housefurnishings, wall-paper, chandeliers, electroliers, radiators and a thousand and one labor-saving devices which go to bring comfort in a modern home. Among all of these the exhibit of electrical appliances is expected to be particularly complete, and all of the new applications of this form of energy are to be shown. This show is being conducted by the Home Exhibits Company, Incorporated, of 52 Broadway, New York city, where additional information may be obtained.

New England and Philadelphia Sections of the Illuminating Engineering Society Elect Officers.

At a meeting of the New England section of the Illuminating Engineering Society, held at Boston, Mass., January 14, the following officers were elected for the ensuing year: Chairman, J. S. Codman; secretary, R. C. Ware; managers, William H. Blood, Jr., and T. H. Piser. The paper of the evening was entitled "Effects of Light Upon the Eye," by Dr. H. H. Seabrook. An abstract of this paper appeared in the issue of the ELECTRICAL REVIEW for January 18.

The following officers have been elected by the Philadelphia section: Chairman, C. O. Bond; secretary, J. D. Israel; managers, H. D'Olier and T. J. Litle, Jr.

Small Turbine Plants.

At the convention of the Northwestern Electrical Association, held at Milwaukee, Wis., January 15 and 16, two papers were read bearing on the equipment and operation of small turbo-electric steam-driven plants. Abstracts of these papers are given herewith:

STEAM NOTES ON A TURBINE PLANT.

BY J. L. HECHT.

In order to confine ourselves to certain definite limits we shall assume that the steam turbine plant in question shall contain 500-kilowatt and 1,000-kilowatt turbo-alternators of the vertical-shaft, Curtis type.

The type of turbine engines being assumed, let us direct our attention, for the time being, to the boilers. We consider it needless to argue here what the type of boiler for this plant should be, for the engineer must be guided by his judgment largely as he would be in the selection of boilers for a reciprocating-engine plant. Of course, we want superheaters in connection with the boilers. Now we know that ordinary dry saturated steam in expanding and doing work, as it would in expanding through a turbine, would tend to become very moist before leaving the turbine, therefore it becomes evident that the proper degree of superheat is such that the steam will be at the point of priming as it leaves the turbine. Unfortunately, however, we reach the practical limits of superheat, to wit, from 100 to 200 degrees Fahrenheit, long before we reach the desired degree of superheat, for in some tests made in Germany several years ago, in which steam at 150 pounds pressure was superheated to a temperature of 1,000 degrees Fahrenheit, it was found that the turbine efficiency increased directly with the superheat. We shall mention briefly a few of the practical difficulties encountered with superheated steam.

The question is very frequently asked, Why is it of advantage to use high vacuums with steam turbines, when there is no advantage in having more than twenty-seven inches of vacuum for a reciprocating engine? The reason is that the steam does its work, in a turbine, in an entirely different manner from the way in which it does its work in a reciprocating engine. In an engine the potential or pressure energy in the steam does the work by exerting a direct pressure on the piston. In a turbine the work is done by the kinetic or velocity energy in the steam. If we will look at the formula for the kinetic energy, $K = \frac{Mv^3}{2}$ in which K equals the kinetic energy, v the velocity, and M equals the mass, we will see that the kinetic energy varies directly with the mass or weight of steam, also with the square of the velocity. Now considering that the turbine nozzles or buckets, at any particular section, have a certain definite area, it is evident that the velocity will increase directly with the increase in volume of steam. Now, if we will refer to the steam tables, we will find that at a vacuum of twenty-six inches, referred to a thirty-inch barometer, one pound of steam occupies 175 cubic feet. If that vacuum is increased to twenty-eight inches, referred to a thirty-inch barometer, a pound of steam occupies 350 cubic feet, or exactly double the volume that it had at two inches less vacuum. Now, since this steam must flow through a certain definite area of opening, it is evident that the velocity of any certain weight of steam at twenty-eight inches of vacuum will be double the velocity of a like weight of steam at twenty-six inches of vacuum, and referring back to the formula for kinetic energy, it is apparent that the kinetic energy is quadrupled, and after passing the twenty-eight-inch vacuum point this increase becomes even more marked. If we increase the vacuum to twenty-nine inches, only one inch increase in vacuum, we again nearly double the volume of the steam and again quadruple the kinetic energy.

If there is plenty of good, fresh condensing water we would of course ordinarily install a jet condenser, because of its simplicity and cheapness. On the other hand, if the condensing water available is such that it would be injurious to the boilers, we would of course install a surface condenser, so that the exhaust steam could be saved and returned to the boilers, there being only a small percentage of loss. Besides the condenser the usual auxiliaries which form a part of the condensing equipment for a steam turbine are a circulating pump, for circulating the condensing water through the condenser; a wet vacuum pump, or condense water pump, which draws the condensation from the condenser and pumps it to the feed-water heater, and which in itself is usually capable of developing a vacuum of twenty-five or twenty-six inches, and a dry vacuum pump, which draws any air or vapor from the condenser which may be in it, and is responsible for the additional two or three inches of vacuum which is usually obtained in this type of condensing equipment. It has often been stated by engineers that it is their opinion that the energy expended in obtaining the extra few inches of vacuum, in a condensing equipment of this kind, amounts to as much as the saving effected by having this additional vacuum. To such of us as have had experience with this kind of an equipment, it is evident that this is not so, for, as explained above, after this twenty-eight-inch vacuum point is reached, each additional fraction of an inch increase in vacuum makes a marked difference in the efficiency and capacity of the turbine; furthermore the only additional piece of apparatus on the condensing equipment is the dry vacuum pump, and when we consider that it is possible to utilize all of the exhaust steam from the auxiliaries for heating the boiler feed-water, as will be mentioned later, it becomes apparent that the amount of energy consumed in getting the extra vacuum is almost negligible.

The question very often arises as to whether the auxiliary machinery in this type of plant should be motor driven or engine driven. It is even argued that the small engines are uneconomical and rather expensive to maintain, and that on the other hand the large generating unit is economical, and that motor-driven auxiliaries will be not only simpler to operate, but more economical. This is the opinion usually arrived at from a superficial consideration, but after going into detail, it is evident that in nearly every instance there is not only no advantage in using motor-driven auxiliaries, but in most cases a decided disadvantage. Placing motors on all the auxiliaries necessarily limits the salable output from the generator. In case of an electrical shutdown in a plant, all the auxiliaries immediately shut down, making it not only more difficult to bring the plant back into operation, but this at times might prove disastrous to the equipment. Further, when we consider that it is of advantage to pump the boiler feed-water to the boilers at the highest possible temperature, it becomes evident that every ounce of exhaust steam from the auxiliaries can be utilized to good advantage in heating the boiler feed-water, and therefore the only energy consumed in the steam-driven auxiliaries is the energy actually doing work in addition to the friction and radiation loss, and actual figures will show that when the exhaust steam from the auxiliaries is used to advantage in heating the boiler feed-water, the actual number of British thermal units consumed in driving the auxiliaries are less with steam-driven than with electrically operated auxiliaries. It might be interesting to state

that we recently made some calculations on the comparative cost of operating a steam-driven and a motor-driven generator for furnishing field excitation to a 3,000-kilowatt plant. The figures show that with coal at $2 a ton, there would be a saving of $200 per month in operating a steam-driven generator. The reason for this was that every pound of exhaust steam from the steam-driven generators could be used to good advantage in heating the boiler feed-water.

ELECTRIC NOTES ON SMALL STEAM TURBINE PLANTS.

BY C. W. PEN DELL.

On account of their high speed the cubical contents and heat radiating surface of turbo-generators are small, which tends to give high-operating temperatures. The fields wherein most of the machine losses are converted into heat are extremely compact and are not cooled except by the air they draw into their centre by centrifugal fan action and discharge outward into the armature winding. The cooling of the armature must be effected by the air whose temperature is already quite high. The excitation must be higher with inductive load than with non-inductive load, consequently the field losses and machine temperature will be higher with a certain kilovolt-ampere load at eighty per cent power-factor than a unity power-factor. Tests have shown that the temperature of a turbo-generator will follow very closely the amount of load on the unit. When with an engine-driven unit it would take the generator a couple of hours to attain the maximum temperature on overload, the turbine-driven generator will reach its maximum temperature corresponding to a definite load in from fifteen minutes to half an hour. This being the case we must evidently take the two-hour overload rating off such generator and connect to the turbine a machine which is capable of carrying indefinitely the maximum load we wish to put upon it. In other words, if a turbine will carry 759 kilowatts with satisfactory speed regulation and steam consumption connect to it a 750-kilowatt flat generator. And specifications covering the generator should guarantee a rise in temperature with 750-kilowatt load at eighty per cent or lower power-factor and should also state excitation current at the power-factor.

The maximum efficiency of a turbine occurs at about twenty-five per cent beyond the point originally assumed as the rated capacity. When operating below this point the efficiency falls off rapidly, but the drop on overload is very slow. This being the case it is often more economical, when investment and fixed charges on a plant are taken into consideration, to operate the turbines at heavy overload, even with reduced economy in steam consumption, and get as great an output as possible from each unit. This is another argument in favor of putting larger generators on turbines than has been the practice.

The uniformity of angular velocity of the steam turbine at all parts of the revolution renders the multiple operation of turbine-driven alternating-current generators more satisfactory than with engine-driven units in that it cuts down the cross-currents that have a tendency to flow between generators whose speeds are not absolutely synchronous at all times. It is difficult to operate engine-driven generators with star connected armatures and their neutral points tied together, on account of the excessive cross-currents which will almost invariably flow. With turbine-driven units, and generators with similar wave forms, there is very little tendency for cross-currents to flow and it is common practice to operate such generators with their neutrals tied together. For satisfactory multiple operation, however, with units of this size and larger, the wave forms must be the same.

Although the general operation of twenty-five and sixty-cycle plants is approximately the same, the design of plants to operate on the two frequencies varies considerably. On account of twenty-five cycles not being satisfactory for lighting purposes there would not be taken, in a twenty-five-cycle plant, as many precautions for the maintenance of constant voltage as there would be in a sixty-cycle plant; this would mean there would be no automatic voltage regulator on the bus or indicator regulators on the various feeders leaving a twenty-five-cycle plant as there would be were it a sixty-cycle system. If the load on a twenty-five-cycle plant were largely rotary converters carrying a lighting load it might be a good proposition to install an automatic voltage regulator on the station bus, but as a rule this would not be done. If the load on twenty-five-cycle plant were synchronous motor-generator sets, induction motors and rotary converters carrying railway load there would be no need to install automatic voltage regulators as none of these machines requires absolutely constant voltage for satisfactory operation, the speed of the station generators being the main thing to watch under such conditions.

In a sixty-cycle plant there should be an automatic voltage regulator which could be made to maintain the bus voltage constant at all times or it could be compounded to raise the voltage as the load comes on. There would then be hand-operated induction regulators on the lighting feeders leaving plant.

On account of the voltage all switches about the plant must be of a type that have their make-and-break contacts immersed in oil and great care should be exercised in the selection of such switches.

The matter of whether there shall be one or two buses in a station is one on which there is a great diversity of opinion. Some claim that the installation of two buses needlessly complicates the station layout and renders trouble and shut-downs more liable; others claim that, although two buses do complicate the station somewhat and render first cost higher, such duplication of buses gives them a greater flexibility of operation which more than offsets the added complication of the plant and extra first cost.

The arrangement of the switchboard for the plant is very important and one on which it pays to put considerable thought. The generators will, of course, be handled by four-pole switches, these being single or double-throw according to whether there is one or two main buses in the station. With a station of the size under consideration it is very doubtful if it would pay to install bus-bars other than at the top and back of the main switchboard and make oil switches hand-operated with electrically operated trips; if the ultimate generator capacity of the station is to be over 3,000 kilowatts it would probably be advisable to install the bus-bars in a brick structure in a basement under the switchboard gallery and use remote control oil switches.

With the buses at top and back of switchboard the wire runs to switches will be short and simple. From the switches wires can be carried on porcelain insulators and iron pins supported on iron pipe work to suitable point where they will go up through floor to feeder regulators, lightning arresters and wire tower. The feeder regulators would be operated by means of chain and sprocket wheels from hand wheels on the switchboard. If there is room to do so the station buses should have sectionalizing switches somewhere near their middle points so that one-half of bus could be killed and other half kept alive; the use of sectionalizing switches at various points in the plant will facilitate greatly the work of any necessary repairs or changes.

For series incandescent and arc lights for street lighting there would be a separate switchboard fed by a three-phase feeder from the main board. The series circuits would be fed by constant-current regulators or constant-current transformers and the board would be arranged so that each circuit could be thrown onto either one of two phases of the system.

On account of the voltage all switchboard instruments would be operated by means of current and potential transformers; the potential transformers stepping voltage down to 110 volts for voltmeters and wattmeters and current transformers would all be of such ratio that full scale deflection would be obtained on ammeters with five amperes flowing in transformer secondaries. This protects switchboard attendant from coming in contact with high voltage and renders the switchboard wiring very much more simple. The design of the station would include all the necessary instruments for getting the instantaneous load on generators and circuits and for recording the kilowatts generated and output to the various feeders.

REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE

A 1,500-Volt Continuous-Current Railway in the Misoxer Valley.

A description is given here of an electric railway connecting the town of Bellinzona with Mesocco, both in Switzerland, which is interesting since the electrical supply is at 1,500 volts direct current. The power station for supplying the railway is at Cebbia, just above Mesocco, on the Moesa river, where there is a fall of nearly 1,000 feet. The length of the road is nearly twenty miles. The grades are heavy and fifty-ton trains are hauled over the line at a speed of twelve and one-half miles an hour. A dam has been thrown across the river so as to form a reservoir from which the pipe-line runs. At the power station there are two 1,000-horse-power turbines, each coupled to a three-phase generator on one side and a continuous-current generator on the other. Between each generator and the turbine is a flywheel and a flexible coupling. The three-phase generators are rated at 420 kilowatts, 10,000 volts, fifty cycles. The continuous-current generators are rated at 275 kilowatts, 1,600 volts. Continuous current is supplied direct to the contact wire at Mesocco, while the high-tension alternating current is transmitted to a substation, where it is transformed, by means of motor-generators, to continuous current at 1,500 volts. There are two of these sets, each with an output of 400 horse-power. The high-tension transmission line is about fourteen miles long, carried on wooden poles with porcelain insulators. The overhead wire is about seventeen feet above the rails, except at tunnels and grade crossings and under bridges. At crossings the height is nineteen feet. The contact wire is divided into six sections, which can be insulated from one another when necessary, though usually connection between adjoining sections is made by means of a short contact wire. Lightning arresters are placed every mile and a quarter. The motor cars are about forty-five feet long, each equipped with four motors, one on each axle. Each motor is rated at sixty-six horse-power, 750 volts, two motors being connected permanently in series. They drive the car through single reduction gears. It is possible to operate two or more cars in a train, the cables for this purpose being run through the cars and coupled together.—*Abstracted from Electrical Engineering (London), January 9.*

State Control of Electricity Supply in Germany.

Considerable stir has been created in Germany by the statement that the Imperial Treasury contemplates making the supply of electricity an imperial monopoly. It appears that the imperial finances are in a serious condition, and that this means is proposed for helping out the situation. Nothing definite is known regarding the intention of the government, but it is believed that the supply of electricity is to be made a monopoly, while the manufacture of electrical apparatus and machinery is to be left free to industrial enterprise. Broadly speaking, the expenditure of the German Empire, as distinct from the expenditures of the states, is covered by indirect taxes, customs, stamp duties, etc. There are also some articles of consumption on which there is an internal revenue tax. The direct taxes go to the states. If the electricity supply is to become an imperial monopoly, this business will be taken out of the hands of the municipalities, where it now frequently is. The public electric power stations are generally owned and managed by the municipalities, or they will become their property at the expiration of the concessions which have been granted to private companies. Most of these supply undertakings are doing well. There is a small number which do not pay. The latter would hardly be more prosperous under government administration. If the government is to buy out these undertakings it must saddle itself with a heavy debt, and will be taking from the municipalities part of their revenue. In other words, the government would help out its income by raising the local taxes. Should this plan go through, the setback to the electrical industry would be very great, because gas engineering is making rapid progress to-day, and any attempt to raise the rates for electricity would cripple it and greatly benefit the gas industry. In addition to the public electricity plants, Germany has a great number of private plants. Many of these are of considerable size, supplying power to large industrial works, and it seems unreasonable for the government to prescribe to the owners of such works where they must buy their power.—*Abstracted from Engineering (London), January 10.*

Jurisdiction of the Interstate Commerce Commission Over Electric Railways.

This communication from James S. Harlan, commissioner of the Interstate Commerce Commission, explains the stand which has been taken by the commission respecting its jurisdiction over electric railroads which operate in two or more states. The act to regulate commerce, as amended, makes no distinction between roads operated by electricity and those operated by steam power, and the commission has not at any time sought to make such distinction. Section 1 of the act, in express terms, brings within its provisions all common carriers engaged in the interstate carriage of passengers or property by rail; and it has been uniformly the view of the commission that the act applies to the electric roads as clearly and as fully as to those operated by steam, when they are engaged in such interstate transportation. This question came up before the commission ten years ago and was decided in this way. From the commission statistics it is thought that about twenty per cent of the entire electric mileage in the country belongs to companies owning property in several states, but this is not the test of whether the roads come under the commissioner's jurisdiction. They do not unless they are actually engaged in interstate transportation. The commissioner says that the commission purposes promulgating systems of accounts for interstate electric railways similar to those now used by the steam railroads. This becomes important as the tendency of electric railroads is more and more to serve as feeders or become branch lines of the trunk line railways. There are now before the commission two cases in which electric roads seek to aid the commission to compel steam roads to join them in establishing through routes and joint rates.—*Abstracted from the Electric Railway Review (Chicago), January 18.*

Proposed Legislation for the Electrical Supply of London, England.

Two bills have been prepared for submission to the British Parliament dealing with the electric power supply in London and the surrounding districts. These bills have been prepared by supply companies themselves, as the London county council has decided to leave the problem to be decided by private enterprise. One of these bills is promoted by the electric lighting companies now serving London, and this proposes that a joint committee shall be created controlling the separate companies; the other bill is for the incorporation of a new company to be called the London & District Electricity Supply Company. The first bill proposes that a joint committee, to consist of representatives of the different companies entering into the agreement and of members appointed by the London county council, shall be appointed. All the generating stations belonging to the companies whose representatives comprise the committee will come under the control of that body and be operated as one undertaking. Rates for distribution are proposed, the maximum being $25 a year per kilowatt of maximum demand plus three-quarters of a cent for each kilowatt-hour used for a contract running less than seven years, this power to be supplied to the present distributing companies. Power may be supplied to private consumers at a slightly increased rate. The bill provides that the London county council may purchase the system at either of two dates; the first being 1932 and the second 1952; but in each case at least three years' notice must be given. The area covered by this bill includes various boroughs of Essex, Kent, Surrey and Middlesex. There are thirteen companies promoting this bill. The second bill provides for an entirely new company, which must have a capital of $22,500,000. The generating station will be at Barking. It is intended to supply power to the present distributing companies as well as to railways, canals and other valuable consumers. The area covered by this bill also includes boroughs of Essex, Kent, Surrey and Middlesex.—*Abstracted from Electrical Engineering (London), December 26.*

The Waipori (New Zealand) Hydroelectric Plant.

A description is given here of the first hydroelectric plant to be built by the New Zealand Public Works Department. The water powers of New Zealand are capable of producing 3,700,000 horse-power after making allowance for all losses in pipes and in generation. The Public Works Department first started to develop a power plant on the Lee river, twelve miles from the city of Dunedin. Here there is a head of 700 feet, but to utilize it required a tunnel one and a half miles long. This system was abandoned, however, after a good deal of work had been done on it, and the rights of a private company on the Waipori river were purchased. This river rises in the Lammerlaw Mountains, about 4,000 feet above sea level. The site of the intake works is at an elevation of 1,250 feet, at which point there is a drop of 700 feet in less than two miles. A dam has been built, and the water is diverted through a short tunnel and a flume to a point above the power-house, where it is let down in pipes. The total length of the flume and tunnels is about two and one-fourth miles. There are two pipes leading to the power-house varying in diameter from forty-two inches at the top to thirty-six inches at the bottom. They are nearly 1,800 feet long. Near the bottom the pipes branch into four fourteen-inch pipes, each leading to a nozzle of an impulse wheel. A six-inch branch is provided for the exciter units, and a four-inch branch leads to an air receiver thirty feet long and thirty-six inches in diameter, which takes up any shocks due to changes in the velocity of the water. As the main supply of water contains a good deal of mud a supply of clear water has been obtained for the transformers and for operating the governors. There are two generating units installed, each consisting of a 1,000-kilowatt, 2,400-volt, fifty-cycle generator, driven by two Pelton wheels. The generators are of the three-phase revolving-field type, and have a regulation of seven per cent on non-inductive load, and fifteen per cent with a power-factor of seventy-five per cent. The wheels are governed by deflecting the nozzles, the governors being of the Lombard type. The wheels are capable of driving the generators at fifty per cent overload. There are two forty-kilowatt exciters, each connected to a sixty-horse-power Pelton wheel on one side and a sixty-horse-power induction motor on the other. The transformer room contains seven 350-kilowatt transformers, from which a voltage of 34,200 volts is obtained. The wiring of the station is in duplicate throughout, permitting either generator to be connected to either of the two transmission lines. Lightning arresters and choke-coils are placed on each wire. The first transmission of energy from this station to the city of Dunedin took place in March last year. This station was not opened for regular operation until April. There is a substation at Halfway Bush and a transforming station in the city. The length of the line is about twenty miles. The entire cost of the installation was said to be about $1,000,000, which includes the cost of the underground distributing system in the city.—*Abstracted from the Electrical Review (London), January 3.*

The Berjonneu System of Electric Transmission of Pictures.

A description is given here of a system of transmitting pictures electrically which has been exhibited in Paris by Pascal Berjonneu. During this exhibition wires were connected up so as to form a loop of telegraph lines from Paris to Marseilles and back, a distance of over a thousand miles. Pictures were transmitted over this at the rate of one each fifteen minutes. Then the apparatus was disconnected from the wires and connected to a number of wireless-telegraph relays, the receiving apparatus, properly connected, was placed in the same room and the pictures were transmitted from one to the other wirelessly, this being the first time that this has been done. The new system does not use selenium, and the apparatus is said to be substantial and small. It is possible to use the system over any line which may be used for ordinary telegraph work or any submarine cable. The line current is small and it is required merely to actuate relays. In brief, the system is merely an adaptation of a Morse key to sending dots and dashes of different lengths. The picture to be sent is etched on metal just as is done to produce a half-tone plate. This metal is thin and is rolled up to form a cylinder which is mounted on a traveling drum similar to that of a phonograph, the feed being one-sixth of a millimetre for each revolution. An insulated platinum point is placed on this, which makes contact only with those portions of the cylinder which stand in relief. As the latter revolves contact is made for a longer or shorter time, causing currents of equal duration to pass over the transmitting wire. In the receiving station a sensitive film is mounted on a similar cylinder, and a ray of light, controlled by a small shutter moved by a magnet through which the line current passes, falls upon the film, thus producing the record. This, of course, consists of lines of dots and dashes one-sixth of a millimetre apart. The intensity of the current does not enter into the operation at all, this acting merely to open or close the window through which the beam of light passes. The system requires, of course, that the sending and receiving apparatus run in synchronism, but the method by which this is secured was not described.—*Abstracted from Electrical Engineering (London), January 2.*

INDUSTRIAL SECTION

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS

Ventilation of the Washington Terminal Tunnel.

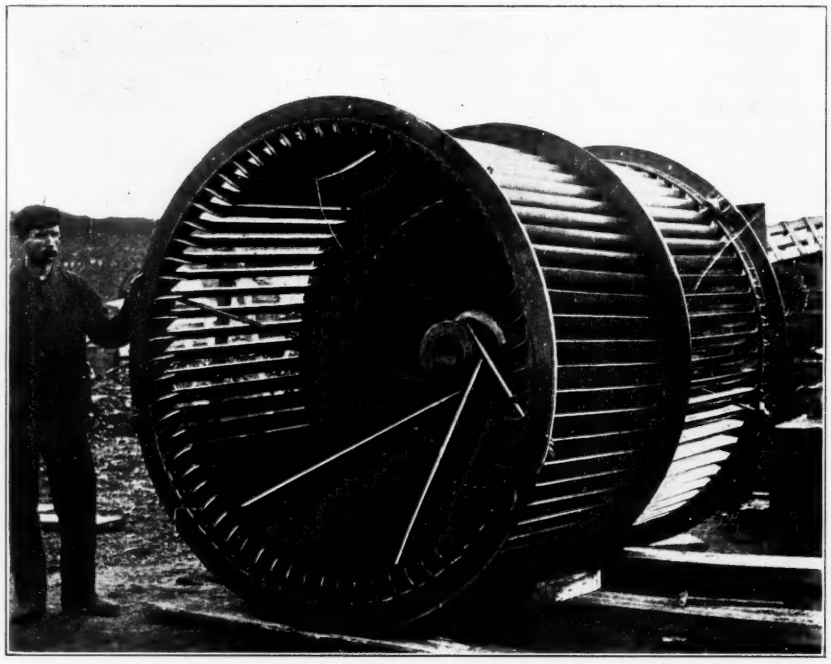
Ventilation of the tunnel through which trains reach and depart from a new Union terminal at Washington, D. C., has been accomplished along lines and by methods that make the installation of especial interest. The problem was that of removing from the tunnel all trace of gas and smoke left by one passing train before another train should enter the tunnel. This called for a high output of air, although the circumstances were such that the ventilating apparatus must be confined to a very small space and attain high efficiency at low expenditure of power.

At a point about 300 feet from the terminal portal were constructed two ventilating ducts, each about five feet wide, which are carried along both side walls of the tunnel to the full height of about eighteen feet, with a cross duct under the tracks, as shown. The space available for the fans on which was imposed the duty of clearing the tunnel of smoke in a few minutes' time was eighteen feet high by thirteen feet in width. In this space it was necessary that the fans and casings should be erected. The drawings printed herewith show the layout of the ventilating installation, the location of the fans with respect to the air ducts, and their emplacement.

The specifications imposed by the Pennsylvania Railroad Company called for two fans 120 inches in diameter, each capable of delivering 230,000 cubic feet of air per minute against a one-and-one-half-inch water gauge. The speed was not to exceed 145 revolutions and the power requirement was limited to 120 horse-power.

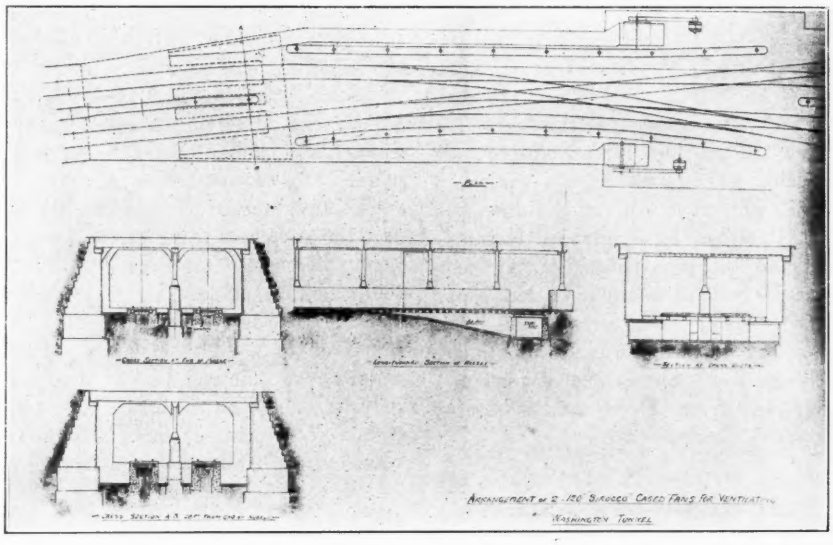
The fans installed are of the Sirocco design, with double inlets corresponding in dimensions, efficiency, speed and power requirement to the specifications just noted. These fans, driven by electric motors, have now been in use for several weeks, and have satisfactorily performed the duty imposed upon them.

Fans of this design represent a distinct development in the science and construction of centrifugal blowers. In a large number of important installations abroad and aboard the latest vessels of the British Navy, the White Star Line, Cunard Line, Hamburg-American Line, American Line and others, they are now adopted wherever the requirement is for high output in connection with limited space.



TYPE OF DOUBLE-INLET CENTRIFUGAL FAN USED IN VENTILATION OF WASHINGTON TERMINAL TUNNEL. OUTPUT 260,000 CUBIC FEET OF AIR PER MINUTE.

Chief among the departures in design noted in the fans installed in the Washington terminal tunnel are the shape, size and number of the blades. It has been found that in all diameters the best results are obtained from sixty-four blades. It will also be noticed that the blades are very short radially, being only one-sixteenth of the diameter of the fan. Axially, however, the blades are unusually long, three-fifths of the diameter. These



VENTILATING INSTALLATION, WASHINGTON TERMINAL TUNNEL. UPPER DIAGRAM SHOWS LAYOUT OF TRACKS AND LOCATION OF FANS AND MOTORS. LOWER DIAGRAM SHOWS CROSS-SECTIONS AT VARIOUS POINTS IN THE TUNNEL.

features of design are not found in any other centrifugal fan.

The outer edges of the blades are bent forward to a set angle in the direction of rotation and are very slightly cupped. The inlet and outlet of the fans are practically equal to the area of the fan itself. The special advantage of the size and shape of the blades is that power-absorbing eddies are almost entirely eliminated and the velocity of the air so greatly accelerated that it actually exceeds the peripheral speed of the blades by as much as seventy per cent. The intake draft of the fan shows practically no variation over its entire area.

How important are these features is shown by the fact that for the Washington installation no fan of the ordinary type less than seventeen feet diameter could be found that would produce the output of air required, and the space available did not permit of the use of a fan of this size.

In tests of smaller sizes of fans it has been found that a Sirocco centrifugal fan thirty by twenty-two by thirty-three inches delivers 2,200 cubic feet of air per minute more than the fan of ordinary type forty-two by thirty-four by thirty-nine inches. As already noted, on shipboard, in mines and in many other installations, this high output as compared to the small space occupied by the fan is of paramount importance.

The power absorbed by the Sirocco fans is indicated above in the specifications limiting the requirement for a fan capable of delivering 260,000 cubic feet of air per minute against a one-and-one-half-inch water gauge to 120 horse-power.

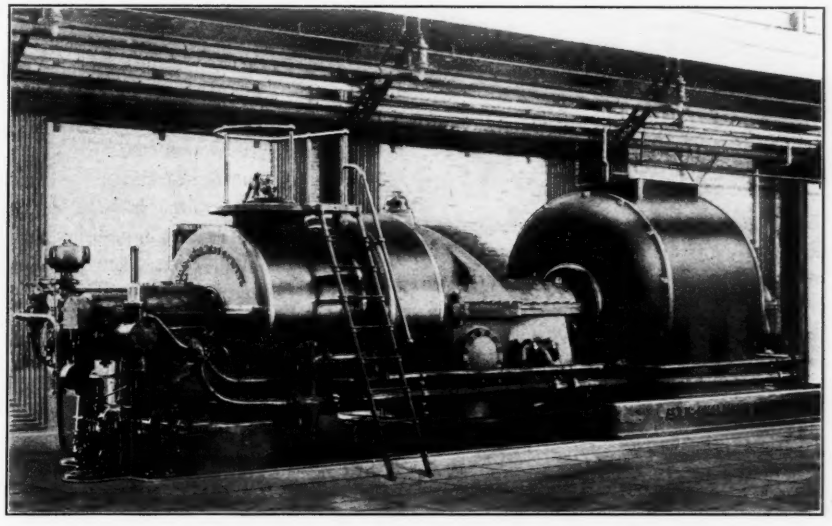
In addition to the installations already mentioned, Sirocco fans are now installed in the Flatiron Building, Broad Exchange Building and Hotel Astor, New York city; Union Station, Pittsburg; three power-houses of the Brooklyn Heights Railroad Company, the New York Edison Company and a number of coal and copper mines, but have not heretofore been manufactured in the United States. They are now to be made here by the Sirocco Engineering Company, of New York, of which William C. Redfield, formerly of the J. H. Williams Company, is president; Hugh T. Coulter, for several years manager of the New York branch of the Davidson Company, general manager, and Thomas Brown, chief engineer.

The estimated production of copper in the United States, Mexico and Canada during December, 1907, was 61,131,760 pounds, against 90,147,370 in December, 1906.—*Copper Gossip.*

Large Steam Turbine Generating Unit for Richmond, Va.

An Allis-Chalmers steam turbine and generator, rated at 3,250 kilowatts on normal load, constituting the largest electric-generating unit thus far installed in Virginia, is now being placed by the Virginia Passenger and Power Company in its Twelfth street station at Richmond. Here it will provide the additional power needed in the operation of the company's street and interurban railway system, which includes the Richmond Passenger and Power Company, the Richmond Traction Company and the Petersburg Electric Railway Company.

This unit, a photograph of which is reproduced herewith, will operate at a speed of 1,800 revolutions per minute, and is designed to deliver three-phase, sixty-cycle current at a pressure of 2,300 volts. From the generator bus-bars the current, after passing through the switchboard, will be stepped up to the transmission voltage and transformed through new 1,000-kilowatt motor-generator sets located in a substation erected on Broad street, whence it will be distributed over the trolley lines at the operating voltage.



3,250-Kilowatt Allis-Chalmers Steam Turbine Generating Unit Installed in the Plant of the Virginia Passenger and Power Company, Richmond, Va.

Under the wise control of the receivers, William Northrup and Henry F. Wickham, represented by the present officers of the company, of which S. W. Huff is general manager, the Virginia Passenger and Power Company has had the most prosperous period in its history; and, with the authority recently granted by the Federal court, liberal expenditures for improvements are now being made, with the object of still further increasing the earning power of the system. Thus far the principal dependence of the company has been upon hydroelectric power derived from the James River, supplemented by current from steam plants, including five generators driven by Allis-Chalmers tandem-compound vertical engines; but rapidly growing traffic has necessitated the purchase of the new steam-turbine unit, which, with its large overload capacity, is expected to provide ample power for some time to come.

Trial Run of General Electric Gasolene-Electric Car.

On January 15 the gasolene-electric car designed by the General Electric Company to meet general railway service conditions, and which was described in the last issue of the Electrical Review, was given a trial run over a circuit of about seventy-eight miles on the tracks of the Delaware & Hudson Railway.

The car received its passengers on the tracks of the Delaware & Hudson Company in the nearly completed new Union Station at Schenectady, N. Y. The route selected made a circuit of about seventy-eight miles in length, running south to the main line or Susquehanna division and from there to Albany; leaving Albany, the car proceeded north through Cohoes and Mechanicsville. It completed the circuit by a run southwest from Mechanicsville to Schenectady. The car contained its full capacity of passengers. A total of twenty-three stops was made, in addition to many unrecorded slowdowns due to signals and other yard restrictions, the average length of a stop being slightly

less than one minute. The engine, however, ran continuously during the trip.

The speed of the car varied from twenty-three miles per hour on a 1.3 per cent up grade to fifty-six miles per hour on a 0.25 per cent down grade, except where traffic conditions and road regulations required lower speeds. Where traffic conditions permitted, a speed of fifty miles per hour was recorded on level track, and from Albany to Mechanicsville a speed of forty-seven miles per hour was sustained on a steadily rising grade.

The operation of the equipment was in every way satisfactory, neither vibration nor sound of the engine reaching the passengers. The car heated readily from the exhaust system, although the day was cold and the air keen. The eight-cylinder gas engine developed at times 150 horse-power, and the two sixty-horse-power motors were under such perfect control of the operator that the acceleration was noticeably smooth and free from jerks. The relatively small space occupied on the car by the power plant and its control by one man are worthy of note.

The car which was used on this test run is a model from which others may be constructed in accordance with the many demands of steam railroads. This combination of gas engine, generator and motors with flexible control is available in connection with special cars for private use as well as on cars designed for inspection, wrecking, baggage or regular passenger service.

Among those present on the initial test trip were the following:

From General Electric Company—C. A. Coffin, president; E. W. Rice, vice-president; J. R. Lovejoy, vice-president; N. S. Hulse; W. B. Potter, engineer, railway and traction department; G. E. Emmons, manager Schenectady works; J. G. Barry, manager railway department; F. C. Pratt; A. W. Jones; F. H. Gale, in charge of advertising; A. H. Armstrong, assistant engineer, railway and traction department; Langdon Gibson, manager production department; Hancock Griffin; H. G. Chatan, railway engineering department; G. H. Hill, assistant engineer, railway and traction department; P. P. Spaulding; H. L. Monroe, manager railway department, Chicago office.

From American Locomotive Company —W. H. Marshall, president; G. M. Basford, assistant to president; B. J. Mellin, designing engineer.

From Delaware & Hudson Company—C. S. Sims, second vice-president and general manager; I. C. Blandy, president Greenwich & Johnsonville Railway Company; A. T. Benjamin, superintendent Delaware & Hudson Company; D. F. Wait, superintendent Delaware & Hudson Company; W. J. Mullin, general traffic manager; J. W. Burdick, general traffic manager; A. A. Heard, general passenger agent; James MacMartin, chief engineer; J. H. Manning, superintendent motive power; Axel Eckstrom, consulting electrical engineer; Ira H. Shoemaker, industrial agent.

E. F. Peck, general manager Schenectady Railway Company, and E. W. Visscher, of Schenectady; E. H. Scofield, chief engineer Twin City Rapid Transit Company, Minneapolis, Minn.

The United Wireless Telegraph Company's Report.

The report of the United Wireless Telegraph Company, which was organized in February, 1907, to take over the affairs of the de Forest Wireless Telegraph Company and to unify wireless interests, states that progress made during 1907 was satisfactory. The number of ships, it is pointed out, which have been equipped with the apparatus of the company has been considerably augmented, and a chain of coast stations completed from New York to Galveston. On the Pacific coast a chain of stations from San Diego, Cal., to the Canadian border is practically finished. Land has also been acquired, the report states, at Vancouver, B. C., for a station, and the erection of a plant at that point will begin as soon as the necessary permit can be secured from the Canadian Government. Stations will also be established on the Alaskan coast this year.

The company, it is claimed, has about 12,500 stockholders. The balance sheet as of November 30, 1907, shows as follows: Assets—Good will and patent rights, $500,000; treasury stock, preferred and common, $6,659,110; stock and bonds of other wireless companies, $12,459,263; works in Jersey City, $23,405; station, boat and aerogram equipment, $229,988; furniture and fixtures, $4,085; cash, accounts receivable, $241,612; total, $20,117,463. Liabilities—Capital stock, $20,000,000; bills payable, $2,534; accounts payable, $114,929.

The Bristol Company at the Chicago Electrical Show.

The Bristol Company, of Waterbury, Ct., with offices in Chicago, New York and London, arranged a very attractive exhibit of its well-known recording instruments at the recent Chicago Electrical Show, a view of the booth being shown herewith.

The company makes such a large line of these instruments that some of them are of interest to every branch of electrical industry.

The exhibit was particularly arranged in groups to show the types of recorders as used in the steam, electric generating and transmission parts of light and power systems. These included recording gauges for steam, pressure and vacuum; recording thermometers for feed-water, flue gases and superheated steam; switchboard recording voltmeters, ammeters and wattmeters and a full line of portable recording wattmeters and ammeters for transmission systems and general testing work. The display was so arranged that visitors could be shown the interior design and construction in a very clear manner.

THE BRISTOL COMPANY'S EXHIBIT AT THE CHICAGO ELECTRICAL SHOW, JANUARY 13-25.

A striking feature of the Bristol booth was a giant model of a recording voltmeter with a facsimile record.

The exhibit was in charge of the Bristol western manager, H. P. Dennis, who was assisted by H. T. Carpenter, factory sales manager, and the Chicago office sales staff.

Electrical Equipment of a Hydroelectric Plant.

The General Electric Company, Schenectady, N. Y., is furnishing the complete electrical equipment for a hydroelectric plant in Nagoya, Japan, a city with a population of about 250,000, situated some 300 miles from Yokohama. The main generating station will be built at Yawozo, on the Naiko river, where power will be generated at 6,600 volts by four three-phase, 2,500-kilowatt, sixty-cycle, 360-revolutions-per-minute water-wheel-driven generators. The generator voltages will be stepped up to the line voltage of 60,000 volts by twelve water-cooled transformers of 1,000 kilowatts' capacity each, and transmitted thirty miles to the main substation just outside of the city of Nagoya. Here the line voltage is to be stepped down to 11,000 volts by nine water-cooled transformers of 1,350 kilowatts' capacity each, and transmitted underground to the distributing station through triple conductor lead-armored cables, the city ordinances prohibiting an overhead transmission of over 2,300 volts.

In the central distributing station the voltage will be stepped down to 3,400 volts by nine water-cooled transformers of 1,350 kilowatts' capacity each, at which potential it is to be distributed throughout the city by both overhead and underground cables.

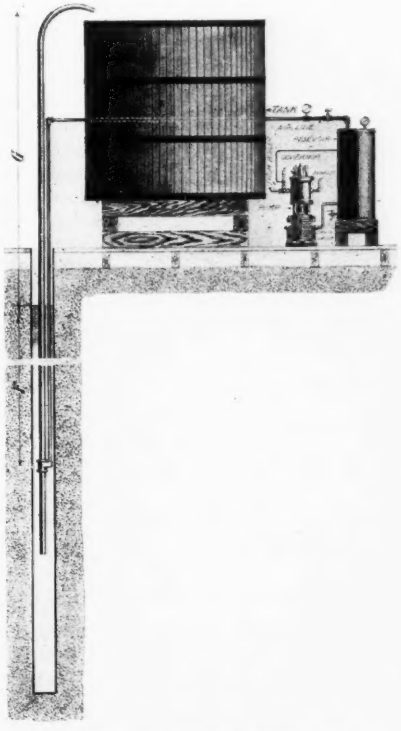
It is interesting to note that from the nearest railway station the entire power apparatus for the Yawozo station will have to be transported on specially constructed wagons hauled by oxen.

The Naiko river is normally forty feet in depth, but in the rainy season the river often rises to forty and seventy feet above low-water mark. This rising characteristic of the river will necessitate the building of a specially designed dam to take care of the high water.

Westinghouse Air-Compressors for Pumping and Conveying Liquids.

The advantages of employing compressed air for pumping water, oil and other liquids from wells, vats and tanks are so pronounced that within the last few years this system has come into general use in a great variety of industries. Its simplicity and ease of maintenance make it far superior to any other means of conveying liquids. In deep wells particularly great economy is found in the use of air as compared with the old-time deep-well pump. The air system requires nothing but pipes properly proportioned as to size, length and connections, which when once placed in position, remain indefinitely without need of attention or repairs.

The air may be compressed in an existing power-house or at any convenient point, regardless of the distance from the well. Several separate wells, if desirable, can be pumped from one central station. Westinghouse compressors, both steam and motor driven, have been found so well adapted to this class of service that they are now extensively employed for compressing air to raise or convey liquids in



AIR-COMPRESSOR FOR PUMPING AND CONVEYING LIQUIDS.

breweries, tanneries, oil wells, dairies, hospitals, chemical laboratories and acid plants, in addition to all kinds of water wells.

Though the problem of pumping by compressed air with given conditions is a simple one, conditions differ so widely that it is impossible to arrive at a satisfactory solution by mathematical analysis. Results of actual tests are necessary to form a correct basis of figuring. Realizing this and desirous of assisting their patrons in every possible way to obtain the best results, the Westinghouse Air Brake Company has lately completed a series of nearly 2,000 tests covering a range of from 350 to 400 different conditions of deep-well pumping, to obtain data concerning water delivered, air consumed and the best proportion and arrangement of piping and apparatus.

Heretofore tests have been made on wells having fixed conditions, and the results, covering a number of isolated cases, have been the only guide in considering the requirements for all other installations. In this case, however, the tests were made with a well driven on the premises of the Westinghouse Air Brake Company specially fitted up for experimental work.

So far as is known, no such wide range of tests has ever before been made upon a single well. The results place the manufacturers in a position to be of great assistance to those desiring to install compressors for direct air-pressure pumping.

The accompanying illustration shows the simple arrangement of piping used when the inside diameter of the well casing permits a discharge pipe and an air-pipe, both of suitable size, to be placed side by side in the casing.

A Practical Demonstration of the Adaptability of Electric Cooking Devices.

E. L. Callahan, manager of the Chicago heating and cooking device department of the General Electric Company was host at an elaborate electrically cooked turkey dinner Friday evening, January 24, at the company's exhibit at the Electrical Show, Chicago. Homer E. Niesz, manager of the Electrical Trades Exposition Company; D. H. Howard, business manager of the Electric City Publishing Company; Herbert Alden Seymour, editor of the *Electric City;* A. D. Blocker, advertising representative of the *Electric City;* James R. Cravath, western editor of the *Electrical World*, and L. W. Marshall, western manager of the ELECTRICAL REVIEW, were the guests.

After the meal the gentlemen unanimously agreed on the adaptability of electric cooking devices and the exceptional ability of Miss Anna B. Lyons and Miss Winifred S. Potts to prepare and serve an excellent meal.

Electrical Contractors' Association of Wisconsin.

The following officers and directors have been elected by the Electrical Contractors' Association of Wisconsin: Christopher Sarau, Oshkosh, president; Herman Andrae, Milwaukee, vice-president; Albert Peterman, Milwaukee, secretary; George Knoerr, Milwaukee, treasurer; J. D. Warden, Sheboygan, director for three years; George F. Rohn, Milwaukee, state director.

Current Electrical News

DOMESTIC AND EXPORT.

McADOO TUNNEL OPENING—With a trainload of invited guests William G. McAdoo, president of the Hudson & Manhattan Tunnel Company, will make a trip through the tunnels under the Hudson river, between New York city and Jersey City, N. J., on Friday, February 7. This trip will be looked on as the formal opening of the tunnel. Unless something unforeseen happens the tunnel will be thrown open to the public on February 15.

BOSTON ELEVATED BONDS—The Boston Elevated Railway Company has sold all of the $5,800,000 bonds authorized last June, thus covering its financial needs for 1908. The actual amount of bonds recently sold was $2,300,000, the other $3,500,000 bonds having been previously disposed of. The first lot of $1,000,000 was issued as four per cent bonds. The company received something under par for these, but the average received for the remaining $4,800,000 was sufficient to bring the average for the entire amount above par. All but a few hundred thousand have already been placed with the public. The Boston Elevated Railway Company has financed the expansion work of the last fifteen or eighteen months.

PROPOSED ELECTRIC ROAD FROM ST. PAUL, MINN., TO SEATTLE, WASH.—An electric railway from Minneapolis and St. Paul, Minn., to the Pacific coast with branches extending into the Dakotas is a new project which is being backed by western men. The company will be known as the St. Paul, Minneapolis & Seattle Electric Railway Company, with a capital of $500,000,000, articles of incorporation having been filed at Pierre, S. D. The branches will extend to Fargo, N. D., and Aberdeen, S. D. The incorporators are: William C. Webber, Rochester, Minn.; David Phillips, Mazeppa, Minn.; Samuel A. Phillips and James Mosop, St. Paul, and Glenn W. Martens, Pierre. The headquarters of the new company will be at St. Paul, Minn.

SALE OF TOKYO STREET ELECTRIC RAILWAY LINES—With reference to the signing of a provisional contract for the municipalization of the Tokyo (Japan) street electric railway, Mayor Ozaki, of Tokyo, has declared that those opposed to the municipalization of the railway severely criticize the city authorities for having purchased the line at the comparatively high price of 67,500,000 yen for ninety miles of existing track, but that their contention is fundamentally mistaken. It is true that from the present line the city authorities will obtain receipts of 3,000,000 yen only per year. In purchasing the railway the authorities were prompted by a desire to extend the line and to realize far greater profits than the above in the future. The existing line will be extended to 110 miles by May next, so that the authorities will be able to obtain receipts of about 4,500,000 yen annually. Further, the authorities will expand the line to 147 miles by the year 1914, when over 8,500,000 yen of receipts will be obtained. In the future the authorities will lay a subterranean electric railway at the rate of 250,000 yen per mile.

MARCONI WIRELESS—Signor Marconi, who left Glace Bay, Nova Scotia, recently, to go abroad in connection with a tentative plan for the installation of stations for wireless transmission across the Pacific, from Vancouver, B. C., to Hong Kong, China, is expected in this country in a few weeks, when experiments will be made looking toward the establishment of a station in the United States for the handling of transatlantic messages. At the present time all business of this class goes to the Canadian company, but the Marconi Wireless Telegraph Company of America has long planned to secure a share of the business now enjoyed by the Atlantic cables. The company does not issue a statement of earnings, but it is said that business between its Atlantic coast stations and ocean liners amounting to about 200 words a day, makes it nearly self-supporting. The Canadian company's service between Glace Bay and Clifton, Ireland, has been in daily operation since October 17, 1907, without interruption, and is handling 1,500 words every day. It is still accepting only press despatches, but the officials expect to extend facilities to commercial matter after February 1. The rate from London to Montreal, Canada, on private messages will be twelve cents a word.

ELECTRIC POWER FOR WASHINGTON MINES—Mines in the eastern part of Okanogan county, Wash.; the Chekapa mines on the west, and the territory reaching from the British Columbia boundary on the north to Brewster at the mouth of the Okanogan river on the south, with boundaries to Chesaw and Molson, in north central Washington, will be supplied with electricity for lighting and power purposes by the Similkameen Power Company, which has received a fifty-year franchise from the commissioners of Okanogan county. The company, capitalized for $1,200,000, has a 1,500-horse-power plant at the falls of the Similkameen river, where it is proposed ultimately to generate 10,000 horse-power. The officers of the company are: President, Monroe Harman, Nighthawk, Wash., president of the Ruby mine and vice-president of the First National Bank, of Oroville; vice-president and secretary, Charles A. Andrus, of Nighthawk; treasurer and general manager, H. W. Johnson, Oroville. The company plans to provide electricity for lighting and manufacturing in the district mentioned, in addition to which its franchise gives it rights to certain streets in Chesaw, Molson, Nighthawk, Loomis, Conconnully, Riverside, Omak, Okanogan and Brewster. The plans take in routes on the east and west banks of Osoyoos Lake to the British Columbia line, and on both sides of the Okanogan river to Brewster, thence on the west side of that river to Brewster. A line is proposed also from Nighthawk *via* Loomis to Conconnully. The town of Oroville is now lighted by the company.

ELECTRIC RAILWAYS.

CAIRO, ILL.—The Cairo city council has granted a fifty-year franchise to the Cairo Terminal Traction Company to build an interurban road. This is a McKinley company.

ERIE, PA.—The Wells Fargo Company has bought the Erie & Cambridge Springs Electric Railway Company, twenty-seven miles long, running from Erie to Cambridge Springs.

BLOOMINGTON, IND.—The city council of Bloomington has granted a franchise to the Grand Central Traction Company, which is to build from Indianapolis, by way of this city, to Evansville.

LINCOLN, NEB.—An interurban railway, between Lincoln and Seward, by way of Emerald, Milford, Pleasantdale and Ruby, with service established by the latter part of July, is under consideration by the Lincoln Traction Company.

DAYTON, OHIO—The Dayton Street Railway Company, of Dayton, of which Albert Emanuel is secretary and treasurer, will begin the work on a street railway in Dayton in the early spring. There will be 11.2 miles of construction undertaken.

CLEVELAND, OHIO—The Forest Park Railway Company has elected the following directors: Lewis E. Carr, Axel Ekstrom, Edgar S. Fassett, L. F. Loree, James McCredie, C. E. McKim, William S. Opdyke, C. S. Sims and W. H. Williams.

PEORIA, ILL.—The directors of the Interurban Railway held a meeting for the purpose of organizing. The organization is as follows: L. W. Morton, president; M. W. Rafferty, first vice-president; J. V. Brokow, second vice-president; W. H. Plattenburg, secretary.

PROVIDENCE, R. I.—Steps toward establishing an electric railway system between Westerly and Ashaway have been taken. The charter as proposed names Leveritt A. Briggs, William J. Battey, Alexander B. Briggs, Frank Hill and John W. Sweeney as the incorporators, and the capital stock is placed at not exceeding $100,000.

ROCKFORD, ILL.—At a meeting of the stockholders of the Beloit Traction Company, an auxiliary to the Rockford & Interurban Railway Company, Joel B. Dow, C. A. Gault and J. A. Vail, of Beloit; T. M. Ellis, W. F. Woodruff and F. W. McAssey, of Rockford, and O. S. Baylies, of Chicago, were elected as the board of directors.

The directors later elected the following officers: President, Joel B. Dow; vice-president, C. A. Gault; secretary, O. S. Baylies; treasurer, W. F. Woodruff; general manager, T. M. Ellis.

TOLEDO, OHIO—At the annual meeting of the Toledo Railways and Light Company the old officers were reelected, and two new directors, J. F. Demess, of Montreal, and W. E. Hutton, of Cincinnati, were elected to the board. No dividend was declared. The surplus for the year ended December 31, 1907, was $323,177 against $466,230 in 1906.

NORTH YAKIMA, WASH.—At the annual meeting of the Yakima Valley Transportation Company the financial statement showed that the actual cost of construction to date, including the cost of right of way, has been $12,000 per mile. Construction work will be resumed early in the spring, the finances of the company being in good shape.

LEBANON, PA.—The Lebanon Valley Street Railway Company has elected the following: President, John A. Rigg, of Reading; directors, John A. Rigg, of Reading; Remi Remont, D. B. C. Catherwood, of Philadelphia; Richmond L. Jones, of Reading; W. A. Rosen, of Philadelphia; Dr. Walter A. Rigg and William R. McIlvaine, of Reading.

COLUMBUS, OHIO—Announcement is made by the Ohio Electric Railway Company that effective January 19 the limited service that was put on by the company December 15, between Columbus and Dayton, has been extended to Richmond, Ind. This will give Columbus a limited electric service of 112 miles, the longest regular and continuous run in this part of the country.

BELLEFONTAINE, OHIO—Three power stations are to be built in Logan county by the Ohio Electric Railway Company. The first one is already under construction south of this city, on the line of the Springfield division, and the other two are to be built on the Lima division. The Lima line is almost entirely graded. All of the bridges and viaducts are in and some of the rails are laid.

MEADVILLE, PA.—The farmers of eastern Crawford county have taken the project of an electric railway to connect Meadville and Titusville into their own hands, and have formed the Central Crawford Traction Company. The object is to build or secure the building of a road to connect with the Meadville-Cambridge line at Longs Stand, four miles east of this city, and with the Titusville road at Clapville, a stretch of twenty miles.

GRAND RAPIDS, MICH.—The Grand Rapids Electric Company, of which J. W. Boynton is the active force, at a meeting of stockholders amended articles of incorporation by increasing the capital from $2,000,000 to $15,000,000. It was also determined that the road should be built from Grand Haven *via* Grand Rapids to Alpena and Bay City and from Grand Rapids to Kalamazoo, Battle Creek, Coldwater and other towns in the southern portion of the state.

AMSTERDAM, N. Y.—It is said that Mohawk Valley and New York capitalists are back of the movement for the building of an electric railroad from Little Falls to Tribes Hill, a distance of thirty-five miles. The road will parallel the New York Central. As soon as the surveying is completed application for a franchise will be made to the State Public Service Commission. The road would connect at Tribes Hill with the Fonda, Johnstown & Gloversville electric road, and complete a trolley system from Albany to Buffalo.

OMAHA, NEB.—Stockholders of the Omaha & Southern Interurban road, now operating a trolley line to Fort Crook and with charter to go on south, have elected these directors: G. W. Wattles, F. T. Hamilton, W. V. Morse, K. C. Barton, Luther Drake, Omaha; C. R. Tyler, Council Bluffs; M. A. Duff, Nebraska City. The directors chose G. W. Wattles, president; F. T. Hamilton, vice-president, and R. A. Leussler, secretary and treasurer. W. A. Smith was appointed general manager, and R. A. Leussler, assistant general manager.

ROCHESTER, N. Y.—The annual meetings of the Rochester Railway and Light Company, the Rochester Railway Company, and the Rochester & Sodus Bay Railway Company were held on January 21. Directors were elected as follows: Rochester Railway and Light Company—Horace E. Andrews, Edward Bausch, W. C. Brown, John Carstensen, Thomas W. Finucane, A. H. Harris, G. A. Hollister, A. M. Lindsay, E. V. W. Rossiter, Eugene Satterlee, J. J. Stanley, H. A. Strong, W. K. Vanderbilt, Jr., Charles T. Chapin, W. Kernan. Rochester Railway Company—H. E. Andrews, W. K. Vanderbilt, Jr., E. V. W. Rossiter, John Carstensen, W. C. Brown, J. J. Stanley, A. H. Harris, G. W. Archer, C. T. Chapin, George F. Roth, W. N. Kernan, G. A. Hollister, D. M. Beach. Rochester & Sodus Bay Railway Company—H. E. Andrews, W. K. Vanderbilt, Jr., E. V. W. Rossiter, John Carstensen, W. S. Brown, Benjamin Strong, G. A. Hollister, Walter N. Kernan, A. H. Harris.

EASTON, PA.—At the annual meeting of the stockholders of the Northampton Traction Company the following directors were elected: Chester Snyder, William J. Daub, F. S. Bixler, A. R. Dunn, W. O. Hay, of Easton; W. R. Grubb, of Bangor; William Bray, of East Bangor; M. P. McGrath, of Worcester, Mass., and H. E. Mitchell, of Philadelphia. Subsequently the directors organized by reelecting the following officers: President, Thomas A. H. Hay; vice-president, H. H. Haines; treasurer, Chester Snyder; secretary, W. O. Hay, and superintendent, D. L. Beaulieu.

BLOOMINGTON, ILL.—The Champaign-Decatur line of the Illinois Traction Company has been finished. This in turn brought to a termination the connection of W. H. Tarrant, of Champaign, chief engineer of construction, with the company. Hereafter R. McCalman, engineer of maintenance of way, will be in charge of the system, the divisional lines being in charge of roadmasters, over whom Mr. McCalman will have jurisdiction, the whole work being brought within the scope of the operating department. The Champaign-Danville division has just been added to his jurisdiction.

GRANGER, WASH.—An electric railroad from Granger to North Yakima is projected. Walter Granger, who has charge of the Government reclamation work in the Sunnyside valley, is one of the leaders in the scheme. Granger will not be touched by the proposed Yakima Valley Transportation Company electric line, and it is to give this town further railroad facilities that the new line is projected. Other men interested in it are W. A. McDonald and J. H. Thomas. Granger is now on the Northern Pacific branch line which runs through the Sunnyside valley, but the service afforded by the latter is not adequate.

WHITE PLAINS, N. Y.—By the appointment of former District Attorney J. Addison Young by Supreme Court Justice Mill as temporary receiver for the Tarrytown, White Plains & Mamaroneck Electric Railway Company, which has debts aggregating $862,490, all the trolley lines in Westchester county which are allied with the Huckleberry, Third Avenue and New York City Railway Company corporations are now in the hands of receivers. Mr. Young is also receiver for the Westchester Electric system at Mount Vernon, while Leslie Sutherland is receiver for the Yonkers Valley road. The total debts of the three corporations amount to about $6,000,000.

JACKSONVILLE, FLA.—Henry M. Endicott, Jr., of Boston, recently bought at public auction, for $70,000, the property of the North Jacksonville Street Railway and Town Improvement Company, popularly known as "The Negro Street Railway." The sale was made to satisfy the judgment in foreclosure of a mortgage in which W. D. Barnett was trustee. It is reported that the road now will become the property of the Jacksonville Electric Company, and that the sale was carried through principally to make the transfer of the property wholly legal. The road was built several years ago by negro capital, and was the only line in the Southern states owned and operated by negroes.

VINCENNES, IND.—The stockholders of the Vincennes Traction and Light Company at their annual meeting elected the following directors: B. G. Hudnut, George E. Henry, Morris Hudnut, William Foley and Charles A. Gordon. The directors met and organized by electing the following officers: President, B. G. Hudnut; vice-president and general manager, George E. Henry; secretary and treasurer, C. A. Gordon. The annual report of the president showed the company to be in an excellent financial condition. The net profits for the year just closed were $13,420.35, the best in the history of the company. A total of 1,162,210 passengers were carried during the year. At the meeting an issue of $100,000 of six per cent preferred stock for improvements was authorized. These contemplated improvements are the extension of the line to the South Vincennes factory district, the double-tracking of the North Vincennes division, the purchasing of additional equipment, and the making of extensive improvements at Lakewood Park. The power-house may also be enlarged.

ELECTRIC LIGHTING.

REED CITY, MICH.—The Reed City electric light plant has been sold to George Westover, of Cadillac, who also owns the lighting plant of that city.

PERKINS, OKLA.—An election has been called for February 3 to vote on the proposition of the city buying the electric light plant. The price to be paid is $3,500.

PARIS, ILL.—The Terre Haute & Eastern Traction Company, of which the local interurban is a branch line, has taken the contract to light the village of Vermillion with electricity.

MARION, OHIO—The Converse electric light plant has been taken over by Fred W. Willson, of Marion, the principal creditor, who will enter into a contract for street lighting.

VALPARAISO, IND.—The town board of Miller has granted former Senator T. E. Bell, of Hammond, an electric light and gas franchise, to run for twenty-five years. Both plants must be in operation within a year.

JACKSONVILLE, ILL.—For the purpose of paying all expenses in extension and permanent improvements connected with the light plant of the city of Jacksonville, the sum of twenty thousand dollars has been appropriated by the council.

DODGEVILLE, WIS.—The city council has authorized its special committee to formulate an ordinance embracing the necessary steps toward the purchase of the electric lighting plant in this city, at present owned and operated by W. J. Pearce.

STROUDSBERG, PA.—The Monroe County Water Power and Supply Company has elected the following officers: President, Van C. Peters; vice-president, W. S. Shafer, and secretary, Hal H. Harris. Other business of a routine nature was transacted.

SPRINGFIELD, MASS.—The gas commissioners have approved of an issue of $250,000 additional capital stock by the United Electric Light Company, of Springfield, to be offered to stockholders at $140 per share. The company petitioned for an issue of $750,000.

PORT ORCHARD, WASH.—John T. Mitchell, of Seattle, has presented an application for a franchise for electric light and power lines over county roads from Colby to Long Lake and vicinity, where plans are being made for extensive improvements for a summer resort.

PLATTE, S. D.—The town council has entered into a contract with A. H. Pease, one of the owners of an electric lighting system which has just been installed, for the lighting of the streets of Platte. The lights will be of the arc variety and of 1,200 candlepower each.

FALL RIVER, MASS.—At the annual meeting of the Fall River Electric Light Company the following were elected: Treasurer, Albert F. Dow; directors, Edward L. Anthony, George A. Ballard, Rufus W. Bassett, Jerome C. Borden, Frederick O. Dodge, Albert F. Dow, Robert S. Goff, Oliver S. Hawes, James E. Osborn.

BATH, N. Y.—The village trustees have voted unanimously to revoke the former franchise and contract made with Tower & DeGroat for lighting the village streets and granted a new franchise to the Citizens' Electric Service Company, which was recently incorporated. The company is allowed four months in which to establish its plant and get it in working order.

FAIRFIELD, ILL.—Before Judge J. R. Creighton in this city the city of Shawneetown was enjoined from buying the electric light plant of that city from Judge Richard Cadle. The plant is a new one, just ready to begin operating, and the city council had voted to buy it. A. G. Richeson and other citizens instituted the injunction. The price agreed on by the council was $17,000.

ST. LOUIS, MO.—Application for an electric light and power franchise, covering all parts of St. Louis county, has been made to the county court by the Clayton Electric Company. R. H. Stevens, of Clayton, attorney and capitalist, who filed the application, would not reveal the names of the men back of the proposed new company, but said a corporation would be formed with a capital stock of $150,000.

CRAWFORDSVILLE, IND.—A valuation of $57,632.33 has been placed on the Crawfordsville electric light plant, a municipal concern, on which an appraisement was ordered at a recent meeting of the city council. The appraisement was ordered at the request of one councilman who is in favor of selling the plant to a New York city concern which has made an offer of $46,000 for it. No action has been taken.

BURLINGTON, VT.—At the annual meeting of the St. Albans Electric Light and Power Company these officers were elected: President, C. C. Chesney, of Pittsfield, Mass.; vice-president, George M. Bunting, of Philadelphia; treasurer, W. H. Vorce, of Dover, Del.; secretary, H. B. Hodge, of Philadelphia; directors, William E. Robertson, Frank H. Foote and W. H. Vorce.

PLACERVILLE, CAL.—The city trustees have received a report from a civil engineer concerning the cost of installing a municipal electric light plant. At Smith's Flat, four miles above Placerville, occurs the fall of the El Dorado ditch. It is estimated that with the power there available for the sum of $20,000 a city plant could be installed and that it will return a profit, above the necessary expense, to the city of $400 per month.

WATERTOWN, ILL.—The Watertown village board has granted an electric light and power franchise to W. H. Downing, of Silvis. The franchise is for a period of twenty-five years. It is stipulated that electric light must be provided by January 1, 1909. The maximum rates of service shall not exceed the rates prevailing in Moline. Mr. Downing agrees to provide three lights for the police and fire service. All-night service will be maintained.

WESTFIELD, MASS.—M. B. Whitney has been elected president of the Westfield Power Company and George C. Dunbar has been reelected superintendent. The company has declared a semi-annual dividend of three per cent. The directors for the ensuing year are: M. B. Whitney, Thomas Little, Charles J. Little, George H. Loomis, Loring P. Lane, George C. Dunbar and Sumner B. Campbell. The last-named is also clerk and treasurer of the company.

TOPEKA, KAN.—The city will be given an opportunity of voting $50,000 in bonds for an enlargement of the city electric light plant at the coming spring election. There are on file 100 petitions for lamps with no probability that the petitions can be considered for the reason that the plant has a capacity of only the present number of lights, 320. It is desired to increase the number by about 200, the increase to be made to consist immediately of 100 lamps with a reserve of 100.

RIVERSIDE, CAL.—The Cinnaminson Electric Light, Heat and Power Company, which furnishes the power for the Camden and Trenton Trolley Company between West Palmyra and Burlington, is rebuilding its lines. So far the new wires have been strung between Riverside and Riverton. The company, which also furnishes current for lighting, is arranging to give a twenty-four-hour service which will allow a number of small manufacturers to install electric power.

EUREKA, CAL.—All of the stock of the Eureka Lighting Company has been transferred to the Humboldt Gas and Electric Company, which will eventually absorb both lighting companies in this city. There are three lighting companies in Eureka—the Eureka Lighting Company, the Humboldt Gas and Electric Company and the North Mountain Power Company. All of the companies are now controlled by the people interested in the North Mountain Power Company.

OWOSSO, MICH.—The Owosso Light and Power Company plans to build a dam 800 feet long and twenty-four feet high. The council has withheld renewal of the contract with other lighting companies because lower prices are promised. Officers have been elected as follows: President, E. M. Hopkins, of Detroit; vice-president, Charles W. Gale; secretary and treasurer, Frank Westcott, of Owosso. These, with several other citizens of Owosso and M. D. Sly, of Detroit, comprise the board of directors.

SALEM, MASS.—At the annual meeting of the Salem Electric Lighting Company the following were elected directors: Charles H. Price, Benjamin W. Currier, George M. Harris, Arthur S. Temple, George H. Shattuck, Henry P. Benson and Henry M. Batchelder. Charles H. Price was reelected president and Henry M. Batchelder treasurer. The president and treasurer and Directors Currier and Harris have served twenty-six consecutive years. The company's investment in real estate, plant and property is over $400,000.

ELECTRICAL SECURITIES.

The steady recovery incident to returning normal banking conditions and the feeling of cheerfulness and optimism which has been gaining full sway for several weeks were broken into last week, and stocks fell back to lower prices both in industrial and railroad issues. This is probably because purchasers of securities have been depressed by reports received from all quarters, indicating curtailment of expenditure and the shutting down of plants. A very hopeful phase of this situation, however, is the reports from the banking institutions of the final elimination of the clearing house certificates which, to the extent of $100,000,000, were issued during the panic days of November. It is stated now that the banks are in a very strong position, and that their surplus has grown by leaps and bounds. Wage reductions have formed an important part of the discussions of large industrial corporations during the last few weeks, and a policy of retrenchment has been put into effect in some cases. There is no doubt that in the near future there will be a flood of applications for capital, but it is also very likely that there will be great discrimination by banks as to the quality and extent of the loans which will be made.

Dividends have been declared upon the following electrical securities: American Gas and Electric Company; regular quarterly dividend of one and one-half per cent on the preferred stock, payable February 1, to stockholders of record January 25. Automatic Electric Company; quarterly dividend of one and one-half per cent, payable February 1. This is a reduction of one-half of one per cent. The company has earned its full dividend, but in view of conditions is adding the amount saved in dividend reduction to surplus. Butte Electric and Power Company; regular quarterly dividend of one and one-fourth per cent, to be paid February 1 to stockholders of record January 28. American Light and Traction Company; regular quarterly dividends of one and one-half per cent on the common and preferred stocks, payable February 1. Multiphone Operating Company; regular monthly dividend of one per cent on stock issued prior to December 1, payable February 1. United Power and Transportation Company; a dividend of $3.31 per share, payable January 30. Connecticut Railway and Lighting Company; regular quarterly dividends of one per cent on both the common and preferred stocks, payable February 15.

ELECTRICAL SECURITIES FOR THE WEEK ENDED JANUARY 25.

New York:	*Closing.*
Allis-Chalmers common	5½
Allis-Chalmers preferred	19
Brooklyn Rapid Transit	43⅞
Consolidated Gas	99
General Electric	120
Interborough-Metropolitan common	6⅞
Interborough-Metropolitan preferred	20
Kings County Electric	93
Mackay Companies (Postal Telegraph and Cables) common	55
Mackay Companies (Postal Telegraph and Cables) preferred	60
Manhattan Elevated	123
Metropolitan Street Railway	20
New York & New Jersey Telephone	100
Western Union	57½
Westinghouse Manufacturing Company	44½

At the annual meeting of the stockholders of the Interborough-Metropolitan Company, six of the retiring directors were reelected for a term of three years. August Belmont, Jr., was elected a director to fill a long-standing vacancy. Six directors reelected are: E. Mora Davison, H. M. Fisher, W. Leon Pepperman, Theodore P. Shonts, R. A. C. Smith, George W. Young.

Part of the proceeds of the sale of the $10,000,000 Western Union bonds which have been listed on the New York Stock Exchange are designed to pay off notes to the amount of $3,567,761, made since June 30, 1906, for the purpose of providing funds to pay for the construction of new lines and wires, and for the purchase of new property. Of these notes $2,500,000 have matured and been paid. The remaining notes for $1,067,761 are not yet due and will be paid from the bond proceeds when due. The remainder of said proceeds are to be used for extensions of poles and wires to follow railroad extension, and to reach other new points as necessary; also, for additions to the number of wires on the poles and for payments for stocks and interest in other companies and for real estate, patents and other new property necessary for the company's business. The bonds issuable under the trust deed are secured by 97,331 shares of fully-paid stock of the New York Telephone Company.

In its application to the New York Stock Exchange to list $9,273,500 of five per cent convertible gold bonds and $3,726,500 of additional said debentures from time to time, the General Electric Company submits a balance sheet which shows a profit and loss surplus for the seven months ending August 31, 1907, of $5,601,192. Sales in that period aggregate $41,475,763, which established a new high record. The total profit and loss as of August 31, 1907, aggregated $20,711,989. The proceeds from the sale of such debentures is to be used for the general purposes of the corporation, and particularly to increase the working capital of the company. These debentures are redeemable on and after June 1, 1911, on ninety days' published notice, at par and five per cent premium and accrued interest, subject to the right of the holder to convert such bond during the ninety-day period into stock. The debentures are convertible on and after June 1, 1911, and until maturity, June 1, 1917, at the option of the holder, into stock of the company at par. The company has stock which has been duly authorized, but not issued, to an amount in excess of $14,000,000 at par. Provision has been made for the reservation of stock to be issued in exchange for this series of debentures.

Boston:	*Closing.*
American Telephone and Telegraph	107½
Edison Electric Illuminating	210
Massachusetts Electric	—
New England Telephone	118½
Western Telephone and Telegraph preferred	65

Directors of the New England Telephone and Telegraph Company have voted to offer to stockholders of record March 17, 39,622 shares of stock, to be issued in the proportion of one share of new stock for eight shares of old. The right to subscribe will expire April 17. Payments will be due, fifty per cent May 16 and fifty per cent August 17. Directors also declared a regular quarterly dividend of one and one-half per cent, payable February 15.

Philadelphia:	*Closing.*
Electric Company of America	8½
Electric Storage Battery common	29
Electric Storage Battery preferred	29
Philadelphia Electric	6
Philadelphia Rapid Transit	15¼
United Gas Improvement	76¼

It is announced that although the depression in business during the last three months of 1907 had its effect on new business, the Electric Storage Battery Company was unusually successful in the large amount of repair work, which netted a greater profit than the same amount of new business. The annual meeting will be held in Camden on the third Wednesday in March. Gross sales in 1906 amounted to $1,331,800; total net income, $1,059,373; dividends, $812,450. The surplus for 1906 was $246,923. It is believed that the annual report for 1907 will show even better.

Chicago:	*Closing.*
Chicago Telephone	—
Commonwealth Edison	88
Metropolitan Elevated preferred	50
National Carbon common	54
National Carbon preferred	102

Directors of the National Carbon Company have declared the regular quarterly dividend of one and three-fourths per cent on the preferred stock, payable February 15. Books close February 4 and reopen February 25.

NEW MANUFACTURING COMPANIES.

ALBANY, N. Y.—The Royal-Eastern Electrical Supply Company has been incorporated with a capital of $35,000. The directors are as follows: Francis E. Neagle, Eugene Congleton and Edward J. Ryan, all of New York city.

AUSTIN, TEX.—The Western Electric Company, manufacturer of electrical goods, with headquarters in Indianapolis, Ind., has been granted a permit to do business. Its capital stock is $50,000 and its Texas headquarters will be in Dallas.

NEW BEDFORD, MASS.—The Massachusetts Electrical Equipment Company, New Bedford, has been incorporated with a capital of $50,000. The directors are: Rufus B. Delano, president; Walter M. Thomas, New Bedford, treasurer, and Harry W. Hathaway. The company will deal in machinery, electrical appliances, etc.

PERSONAL MENTION.

MR. JAMES B. OLSON, sales manager of the Habirshaw Wire Company, New York, was a visitor at the Electrical Show, Chicago, last week.

MR. WILLIAM LOEB, JR., secretary to President Roosevelt, has been elected a director of the Washington (D. C.) Railway and Electric Company. Allan L. McDermott was elected president.

MR. N. MINER has resigned as new-business manager for the Union Electric Company, of Dubuque, Iowa, and has accepted a position as manager of the new-business department of the Topeka Edison Company, Topeka, Kan.

MR. PETER C. DOLAN, general manager of the Pittsfield (Mass.) Electric Street Railway Company, has been elected president of the road, to succeed Judge Joseph Tucker, who died recently. Mr. Dolan has been connected with the road for more than fifteen years.

MR. J. WARREN ARCHER has established an office at 114 Liberty street, New York city. Mr. Archer is a machinery expert and appraiser, and makes a specialty of power-house equipment and steam machinery for power-houses, street railways and lighting companies.

DR. SAMUEL SHELDON, professor of electrical engineering at the Brooklyn Polytechnic, lectured before the Brooklyn Institute of Arts and Sciences, in the Department of Electricity, on "The Functions of the Electrons in Electric Light Sources," on Wednesday, January 22. Dr. Sheldon is president of the Department of Electricity of the Brooklyn Institute of Arts and Sciences.

MR. ALFRED A. WOHLAUER, New York city, announces that he has opened an office at 500 Fifth avenue, and is prepared to investigate and report on all matters relating to electric light and heat, to design and supervise electric light and heat installations, and to advise as to the possibilities with new propositions and as to the extension and improvement of existing installations.

MR. JOHN BLAIR McAFEE, of Philadelphia, Pa., has been made assistant to President R. Lancaster Williams, of the Norfolk & Portsmouth Traction Company, Norfolk, Va. Mr. McAfee has been chairman of the operating committee of the traction company. He represents Chandler Brothers & Company, of Philadelphia, who are associated with Middendorf, Williams & Company, of Baltimore, Md.

MR. WILLIAM W. POWER has recently been appointed manager of the electrical department of the Boston branch of the H. W. Johns-Manville Company. Mr. Power was formerly district manager of the Allis-Chalmers Company's Philadelphia office. Previous to that he was connected with the Christensen Engineering Company, as special representative throughout the New England states. Mr. Power is well and favorably known throughout this territory, and his wide experience in the electrical field, combined with a most pleasing personality, will assist him in his new position in charge of the electrical business of the H. W. Johns-Manville Company throughout New England.

OBITUARY NOTES.

MR. WALTER L. TYLER, a member of the A. B. See Electric Elevator Company, died on January 22, at his home, 80 Pierrepont street, Brooklyn. He was forty-one years old, and was graduated from Columbia in the class of 1887. Mr. Tyler was a life member of the Crescent Athletic Club and member of the Psi Upsilon Fraternity, the Hardware Club, and the Hamilton Club, of Brooklyn. He was also a director of the Flatbush Trust Company, vice-president and director of the Home Title Insurance Company, and a trustee of the Church of the Pilgrims.

BRIGADIER-GENERAL ANTHONY HEGER, U. S. A., retired, died on Friday, January 24, at his home in New York city. General Heger was born in Austria eighty years ago. He began the study of medicine in that country and took his degree as a physician at the University of Pennsylvania. He entered the regular army as an assistant surgeon in 1856, and at the close of the Civil War was brevetted lieutenant-colonel. He was made assistant surgeon-general in 1891, and retired from the service the following year. General Heger gave much of his time to the study of mathematics, and was the author of several text-books. He leaves a widow and two sons—William S. Heger, of Milwaukee, Wis., and Dr. Anthony Heger, of New York city.

INDUSTRIAL ITEMS.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, is distributing a folder descriptive of the "Linolite" system of lighting.

G. M. GEST, New York and Cincinnati, engineer and contractor, was represented by W. T. Jackson, of the Cincinnati office, at the Chicago Electrical Show last week.

THE ROCKWELL ENGINEERING COMPANY, 26 Cortlandt street, New York city, has issued a new folder describing and illustrating Rockwell portable heaters for oil fuel.

THE L. B. ALLEN COMPANY, INCORPORATED, Chicago, Ill., is sending out a little booklet entitled "If You Use Solder," calling attention to the Allen soldering stick, paste and salts.

THE STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, Pa., was well represented at the Chicago Electrical Show by J. R. Wiley, manager of the western sales department; W. M. Rogers, J. E. O'Neill and A. B. Saurman.

WILLIAM H. BRISTOL, 45 Jersey street, New York city, in Catalogue No. 20, describes his electric pyrometers for blast furnaces, indicating, recording and combination outfits. Copies of this catalogue may be secured upon request.

THE STANDARD STEEL WORKS, Philadelphia, have published a handsome catalogue devoted to springs for railway and electric traction service. This catalogue will be found of great value to managers and promoters of railway systems.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, Warren, Ohio, has ready for the trade Price List No. 108. This reduces to the greatest simplicity full data concerning the company's wide range of standard and special incandescent lamps.

THE MASSACHUSETTS CHEMICAL COMPANY, of Walpole, Mass., manufacturer of insulating tapes, varnishes, etc., is about to open a branch office in Chicago, to be located at 464 Monadnock Building. Arthur E. Duclos, well known to the electric trade in the Middle West, will be in charge.

THE CALCULAGRAPH COMPANY, New York city, is distributing a reprint of an article entitled "A New Idea in Time Recording, and Its Advantages in Cost Accounting," by Robert W. Higgins. Mr. Higgins was for nine years in charge of the costs, prices and estimates for the Gorham Company, manufacturers of silverware, Pawtucket, R. I.

THE H. T. PAISTE COMPANY, Philadelphia, Pa., has published Price List No. 9, devoted to electric light supplies. Copies of this price list may be had upon request. The company has also published Catalogue No. 14, devoted to electric wiring supplies. This catalogue is illustrated throughout, and the arrangement is such that the literature pertaining to any character of apparatus may be easily discovered.

THE JEWELL ELECTRICAL INSTRUMENT COMPANY, Chicago, Ill., put its meter to a very severe mechanical test during the Electrical Show at the Coliseum, Chicago. Edward W. Jewell, president of the company, used the movement of one of the company's well-known "Baby" voltmeters in place of a hammer to drive nails around the booth. Apparently the meter stood this test without in any way becoming deranged or put out of order.

THE DETROIT FUSE AND MANUFACTURING COMPANY, Detroit, Mich., is placing on the market a complete line of indicating fuses designated as the "Arkless." These fuses are National Electrical Code Standard, and are made in the ferrule-contact, spring-clip style for 250 volts, zero to thirty amperes and thirty-one to sixty amperes. In the knife-blade, switch-contact style they are made for 250 volts, sixty-one to 600 amperes. They are also made for 600 volts, zero to 100 amperes.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., has published a booklet entitled "Dixon's Graphite Brushes." The company has endeavored to include in this booklet as much definite and practical information concerning the use of graphite brushes as it is possible to concisely give. The booklet begins with a description of the electrical installation of the Dixon company, explaining how Dixon's graphite brushes were first tried. Under headings of "Conditions of Service" and "Variables in Commutation," the booklet goes on to point out conditions under which graphite brushes are best

used and states what requirements must be met in their use. There are a few useful hints in the book of a general nature concerning brush tension and how to easily measure it, the care of the commutator, etc. Copies of this booklet may be obtained by writing to the company.

THE WESTERN ELECTRIC COMPANY, Chicago, Ill., is about to issue a bulletin devoted to the Beck flaming arc lamp. This bulletin will be fully descriptive of the most recent and important developments, and will give full data concerning the performance of this illuminant. The lamps as now manufactured are suitable for use on either alternating or direct currents, and have been so greatly simplied in construction that but little skill is required in operating. This line of arc lamps will supplement the already well-known line of enclosed arc lamps manufactured by the Western Electric Company.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., Bulletin No. 1604, describes an hydraulic transmission pump designed to meet the requirements of plants where steam economy is an important factor in the cost of production. This pump is built for any capacity desired up to 400 gallons per minute, and pressures as high as 6,000 pounds per square inch. For capacities and pressures beyond this, the company offers another pump of special design. Pumps of this type are particularly adapted for operating under conditions that entail hard and continuous service, as in mines, for forcing fluids through pipe-lines, or for the operation of hydraulic presses, lifting machines and cranes, riveting, bolting, forging and testing machines, and apparatus of all kinds which depend for their successful operation upon the delivery of water or other liquids under heavy pressure. Complete descriptive matter can be had upon application.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has issued several new bulletins. Bulletin No. 4555 describes the application of electricity to cement plants, and gives a large amount of information regarding the different processes and the apparatus used. A list of plants in which General Electric equipments have been installed is given. Bulletin 4556 describes and illustrates the series luminous arc rectifier system developed by the company. This system, it is stated, permits the operation of direct-current luminous arc lamps from alternating-current central stations at high economy and with extreme simplicity. A new line of cylinder controllers with improved magnetic blowouts is described in Bulletin No. 4557. At present three controllers, known as the K-34, K-35 and K-36, are being built. The K-34 controller is suitable for use with either two 150-horse-power or four seventy-five-horse-power motors, the K-35 with either two 100-horse-power or four fifty-horse-power, and the K-36 with two motors only, each of sixty-horse-power or less. The K-34 and K-35 controllers are provided with bridge connections and maintain full current through all motors during the transition period from series to parallel, giving a smooth acceleration and reducing the strain on motors and gearing. A powerful magnetic field is produced by means of individual blowout coils and arc chutes which insure the extinction of the arc under all operating conditions and reduce the burning and repairs to a minimum. The bulletin gives the details of construction and dimensions of the different controllers.

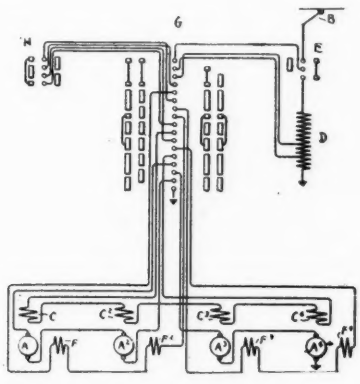
Record of Electrical Patents.

Week of January 21.

876,923. STARTING MOTOR-CONVERTER. Ernst F. W. Alexanderson, Schenectady N. Y., assignor to General Electric Company. Means are provided for reducing the effective number of turns in the field winding at starting.

876,924. COMPENSATED MOTOR. Ernst F. W. Alexanderson, Schenectady, N. Y., assignor to General Electric Company. A system of controlling alternating-current commutator motors of the compensated type.

876,930. DYNAMOELECTRIC MACHINE. Sven R. Bergman, Lynn, Mass., assignor to General Electric Company. A continuous winding of magnetic material covers the exterior of the armature.



876,924.—COMPENSATED MOTOR.

876,939. INSULATOR. Harold W. Buck, Niagara Falls, N. Y. An insulator of the corrugated-reel type supported horizontally on two pins.

876,943. DYNAMOELECTRIC MACHINE. Charles E. Canfield, Norwood, Ohio, assignor to Stanley Electric Manufacturing Company, Pittsfield, Mass. An inductor generator.

876,949. ARMATURE BANDING. Malcolm Dickerson, Newark, N. J., assignor of one-half to Frederick L. Luz, Newark, N. J. The armature is banded with two layers of wire wound in opposite directions.

876,952. RELEASE MECHANISM FOR MORSE TELEGRAMS. Eugene Ducretet, Paris, France. The armature of the controlling electromagnet is provided with a depending pawl.

876,955. DYNAMOELECTRIC MACHINE. Russell S. Feicht, Pittsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. An end ring built up of annular sections.

876,956. GAS CAP. Richard Fleming, Lynn, Mass., assignor to General Electric Company. A cap for arc lamps with a doubly spiral passage.

876,970. ELECTRIC SWITCH. Walter F. Jones, Eccles, near Manchester, England, assignor to Westinghouse Electric and Manufacturing Company. A rotatable switch.

876,979. POTENTIAL REGULATOR. Edwin Lehr, Wilkinsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company. A combination of series and three-phase transformers for giving simultaneous potential regulation between the different lines.

876,984. ELECTRIC FUSE. Frederick Mackintosh, Schenectady, N. Y., assignor to General Electric Company. The fuse cartridge is contained within an air-tight casing.

876,988. TRANSFORMER FOR ELECTRIC VEHICLES. Walter S. Moody, Schenectady, N. Y., assignor to General Electric Company. A transformer core comprising a number of legs and windings.

876,993. MOTOR CONTROL. Karl A. Pauly, Schenectady, N. Y., assignor to General Electric Company. Automatic means for varying the resistance in the secondary circuit of an induction motor.

876,996. INTELLIGENCE INTERCOMMUNICATION BY MAGNETIC-WAVE COMPONENTS. Greenleaf W. Pickard, Amesbury, Mass. A rectangular antenna for utilizing the magnetic components of electric waves.

877,002. TELEGRAPH SYSTEM. Harry O. Rugh, Sandwich, Ill. Means are provided for preventing the connection of the local batteries to the line at any station.

877,005. ELECTRIC LOCOMOTIVE. Richard Schwarz, Schenectady, N. Y., assignor to General Electric Company. A gearless motor drives the wheels through a spider and compression springs.

877,016. ELECTRIC MOTOR. Leonard A. Tirrill, Lynn, Mass., assignor to General Electric Company. A motor for driving tools or the like.

877,017. DYNAMOELECTRIC MACHINE WITH COMPENSATING WINDINGS. Ludwig Torda, Chiswick, England. The pole pieces are built up of a plurality of sections bolted to the frame.

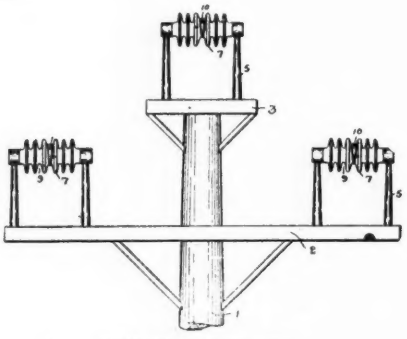
877,018. OPERATION OF STORAGE BATTERIES IN CONNECTION WITH ALTERNATING-CURRENT SYSTEMS. Joseph H. Tracy, Philadelphia, Pa. A booster and rotary converter are employed with an automatic regulator for operating a storage battery on an alternating-current system.

877,026. TRANSFORMING THE ENERGY OF ELECTRIC CURRENTS. Ezechiel Weintraub, Schenectady, N. Y., assignor to General Electric Company. A vapor converter with a plurality of cathodes and electromagnets for shifting the cathode spot, whereby a direct current is converted into an alternating current.

877,028. MOTOR CONTROL. Harold E. White, Schenectady, N. Y., assignor to General Electric Company. A multiple-switch-control system.

877,030. MOTOR CONTROL. Carl E. Zix, Berlin, Germany, assignor to General Electric Company. An electric motor with a divided field winding and a switch for reversing the direction of rotation.

877,033. SWITCHING MECHANISM FOR TELEPHONE CIRCUITS. Albert K. Andriano, San Francisco, Cal., assignor to Direct-Line General Telephone Company. An intercommunicating system.



876,939.—INSULATOR.

877,034. GYROSCOPE. Hermann Anschütz-Käempfe, Kiel, Germany. An electrically driven gyroscope.

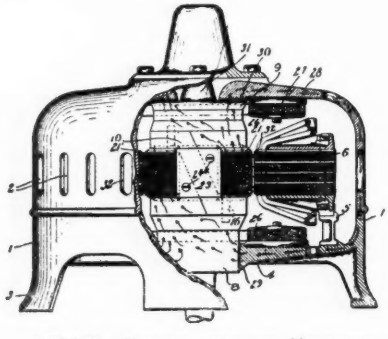
877,058. TELEPHONE SYSTEM. William W. Dean, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. A central exchange system using two main batteries.

877,069. MAGNETIC DETECTOR. Lee de Forest, New York, N. Y., assignor to George K. Woodworth, Boston, Mass. A number of magnetizable cores placed annularly with magnets rotating opposite their ends.

877,089. METHOD OF MAKING ELECTRIC CONDENSERS. Frank S. Koch, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. The insulated plates are placed in a case saturated with paraffin and compressed.

877,121. TELEPHONE SYSTEM. Howard M. Post, Chicago, Ill., assignor to Kellogg Switchboard and Supply Company, Chicago, Ill. A central exchange system using two sources of current.

877,126. TROLLEY-POLE CONDUCTOR. Oscar A. Ross, Chicago, Ill. The force of the supporting spring may be applied at either of two points.



876,943.—DYNAMOELECTRIC MACHINE.

877,144. SYNCHRONIZING APPARATUS FOR ALTERNATORS. Max Vogelsang, Frankfort-on-the-Main, Bockenheim, Germany, assignor to the firm of Voigt & Haeffner, Atkiengesellschaft, Frankfort-on-the-Main, Germany. An automatic switch which operates when currents of the correct frequency are passed through the winding.

877,171. METHOD OF MANUFACTURING METALLIZED ELECTRIC INCANDESCENT-LAMP FILAMENTS. Francis M. F. Cazin, Hoboken, N. J. A carbon core is coated with an electrolytic layer of metal.

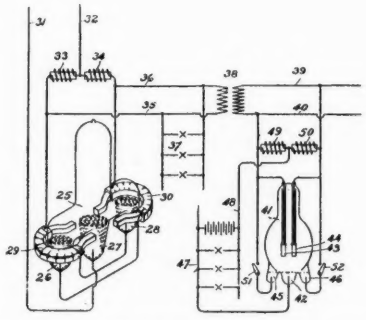
877,172. METHOD OF PRODUCING FILAMENTS FOR ELECTRIC INCANDESCENT LAMPS AND THE PRODUCT OF SUCH METHOD. Francis M. F. Cazin, Hoboken, N. J. A shaped carbon core electrolytically plated.

877,183. ELECTRIC HEATER. George W. Elkins, Elkins Park, Pa., assignor of one-half to Henry D'Olier, Jr., Philadelphia, Pa. A heater for attachment to a water faucet.

877,242. INSULATOR PIN. Delos V. Snapp, Holdrege, and Charles W. Fraher, Lincoln, Neb. A pin provided with a body portion upon which the insulator is placed.

877,251. ELECTRICAL MEASURING INSTRUMENT. William J. Still, Ealing, England. An electromagnet with movable armature and a double winding.

877,258. AUTOMATIC REGULATING DEVICE. Percy H. Thomas, Montclair, N. J., assignor to Cooper Hewitt Electric Company, New York, N. Y. Means for controlling the time of application of the increased pressure required to start a current through a vapor conductor.



877,026.—TRANSFORMING THE ENERGY OF ELECTRIC CURRENTS.

877,311. ELECTRIC SIGNALING APPARATUS. Sydney Evershed, London, England, assignor to himself and Evershed & Vignoles, Limited, London, England. An indicator controlled through two electromagnets and resistances.

877,312. ELECTRICAL TRANSMISSION APPARATUS. Sydney Evershed, Chismick, England, assignor to himself, and Evershed & Vignoles, Limited, London, England. A receiver controlled by a subdivided resistance and multiple point switch.

877,319. TRANSFORMER EMPLOYED IN HIGH-FREQUENCY-CURRENT CIRCUITS. Georges E. Gaiffe, Paris, France. A combination of primary and secondary oscillating circuits, the former being protected from excessive potential strains.

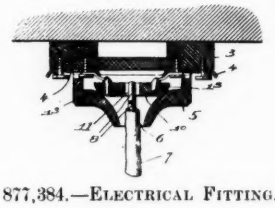
877,369. ELECTROPNEUMATIC MACHINE. William K. Rankin, Philadelphia, Pa., assignor to John E. Reyburn, Philadelphia, Pa. A motor-driven cylinder pump.

877,379. TROLLEY REPLACER. George Q. Seaman, New York, N. Y. A spring automatically lowers the pole if the wheel leaves the wire.

877,383. MEANS FOR SECURING CORDS TO LAMP SOCKETS. Frederick A. Swan, Cliftondale, Mass. The wire is threaded through a plate in the socket which takes up the strain.

877,384. ELECTRICAL FITTING. Frederick A. Swan, Cliftondale, Mass. Strain is taken off the terminal clamps by threading the wire through a supporting washer.

877,408. MANUFACTURE OF ELECTRIC INCANDESCENT LAMPS. Francis M. F. Cazin, Hoboken, N. J. A carbon fillet is coated with a layer of ruthenium-osmium.



877,384.—ELECTRICAL FITTING.

877,451. MEANS FOR RECEIVING INTELLIGENCE COMMUNICATED BY ELECTRIC WAVES. Greenleaf W. Pickard, Amesbury, Mass. A massive solid conductor of low resistivity is placed in contact with a non-metallic solid of high resistivity, the junction thus formed having electromotive power.

877,458. ELECTRIC TRACK-SWITCH. Rollin A. Baldwin, New Haven, Ct., assignor to Baldwin & Rowland Switch and Signal Company. A track switch controlled by a solenoid.

877,464. RAILWAY SIGNAL.—John C. Link, Highbridge, Wis. A signal controlled by a mercury switch.

877,467. COOLING SYSTEM FOR ELECTRIC RAILWAY APPARATUS. Walter S. Moody, Schenectady, N. Y., assignor to General Electric Company. Compressed air is circulated around the apparatus.